VISUAL FUNCTIONS IN CHILDREN AND YOUNG ADULTS WITH REFRACTIVE ERRORS

DISSERTATION SUBMITTED TO

THE TAMIL NADU Dr. M.G.R. MEDICAL UNIVERSITY

CHENNAI – 600 032, INDIA

M.S. DEGREE EXAMINATION

BRANCH – III OPHTHALMOLOGY

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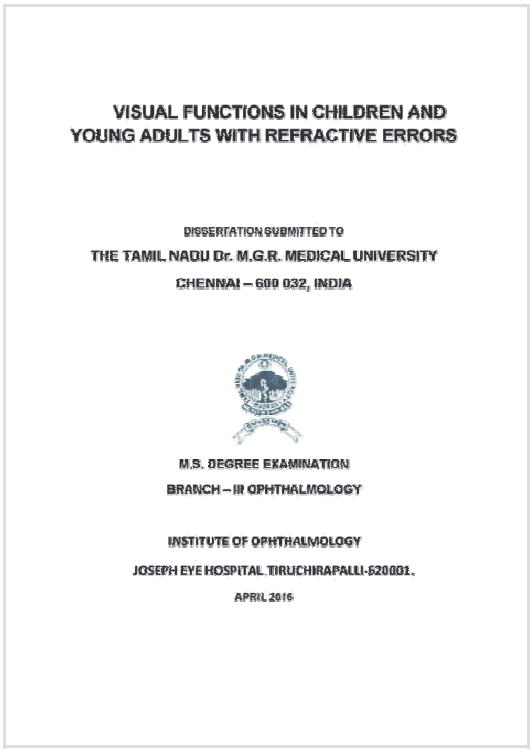

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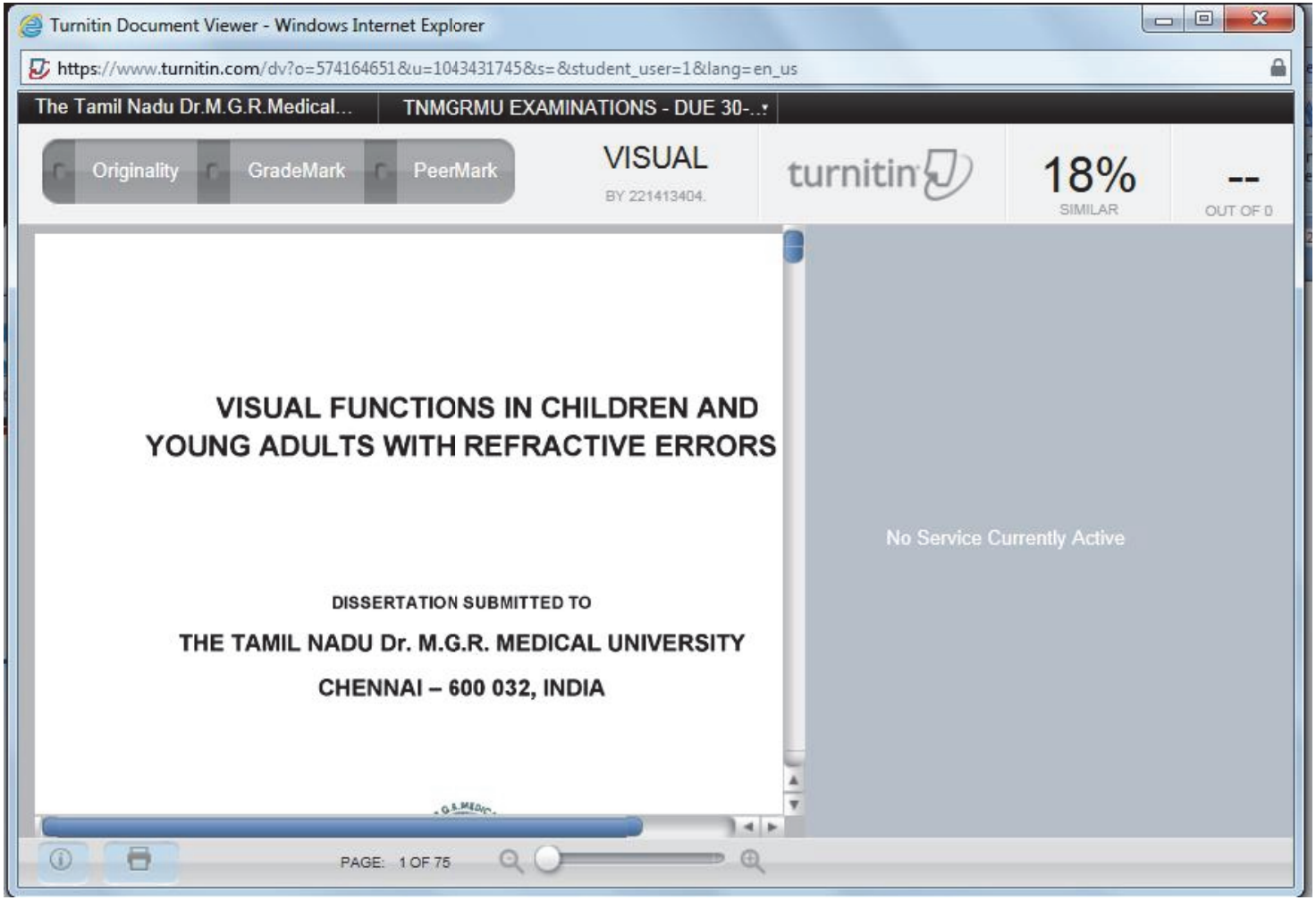
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This is to certify that the dissertation entitled **"VISUAL FUNCTIONS IN CHILDREN AND YOUNG ADULTS WITH REFRACTIVE ERRORS"** is a bonafide work done by **Dr. L.K.LALI, M.B.B.S., D.O., postgraduate student in M.S (Ophthalmology) during JUNE 2014 to MARCH 2016,** under the guidance of **Dr. TANUJA BRITTO, M.S., D.O.,** Professor and HOD, Department of Low Vision, Joseph Eye Hospital, Trichy, in partial fulfillment for the award of M.S degree in Ophthalmology for the Tamil Nadu Dr. M.G.R. Medical University, Chennai.

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CERTIFICATE

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DECLARATION BY THE CANDIDATE

I, **Dr. L.K.LALI, M.B.B.S.,D.O.,** solemnly declare that the dissertation entitled **"VISUAL FUNCTIONS IN CHILDREN AND YOUNG ADULTS WITH REFRACTIVE ERRORS**" has been prepared by me, under the direct guidance of **Dr. TANUJA BRITTO, M.S., D.O.,** Professor and HOD, Department of Low Vision, Joseph Eye Hospital, Trichy, and **Dr. B. ANTONY AROCKIADASS, M.S.,** Assistant Professor, Department of Pediatric Ophthalmology, Joseph Eye Hospital, Trichy, during the period from August 2014 to May 2015, in partial fulfillment for the award of **M.S Degree in Ophthalmology** for the Tamilnadu **Dr. M.G.R., Medical University**, Chennai.

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Introduction

INTRODUCTION

The World Health Organisation (WHO) and VISION 2020 report states that uncorrected refractive errors (43%), unoperated cataract (33%), and glaucoma (2%), are the important causes of blindness and low vision globally. Of these, refractive errors has been identified as one of the main cause of visual impairment in children and young adults, leading to drastically reduced productivity, educational opportunities and quality of life.[1]

Normal visual functioning depends not only on patient's visual acuity but also on many other parameters, such as the visual fields, perception of colour, contrast and visual skills[2]. Clinically, objective measurements, such as those of acuity or the visual fields, provide an assessment of a patient's visual status but do not reflect the degree of visual impairment that the patient experiences in his or her daily activities, sufficiently.

It has been documented that there is no correlation between subjective complaints and objective measurements of difficulty in patients with visual impairment[3]. There is a paucity of literature on how functional visual performance improves with correction of refractive errors. The improvement of visual functions after correction of refractive error has been inferred based on improvement in visual acuity only.

In general, visual impairment and low vision affects the visual functioning of a person in areas like orientation and mobility, in day-to-day communication skills, with the daily living activities and prolonged near tasks

such as reading[4]. The effect on these four areas depends on the type and degree of impairment. Visual impairment also affects various aspects of life which include a person's educational status, occupation and leisure activities.

Impairment of vision affects the quality of life which is related to health, and affects the daily activities of life, including social activities (Elliot AF, 2009). The efficacy of interventions should be validated by patient's visual functions and by assessing visual or impact of visual impairment on daily activities.[5]

Children and young adults with low vision have different needs from that of their peers, necessitating residual vision enhancement. Residual vision can be enhanced by thorough clinical assessment and correction of refractive errors by glasses or contact lenses[6]. These patients should also be trained to use optical and non-optical aids if needed, through adaptation of environment and teaching methods. This is very important especially in children, because any delay in development of visual skills will affect their education. Early referral and intervention have great potential to impact on visual outcome as well as on participation in family, school and community life.

The current study was done to identify the differences in visual functions like visual acuity, contrast sensitivity, colour vision, stereopsis, visual fields etc. in patients with refractive errors between individuals with normal best corrected visual acuity and individuals suffering from visual impairment This study also aimed to document the improvements in subjective and objective visual parameters in individuals in whom interventions were made.

Aim of the Study

AIM OF THE STUDY

To evaluate visual functions and visual performance in children and young adults, aged 5-30 years with refractive errors, and the effectiveness of ophthalmological interventions on functional visual skills like reading and writing.

SPECIFIC OBJECTIVES OF THIS DISSERTATION

a) To document refractive errors in patients aged 5-30 years,

b) To assess the visual functions in patients with refractive errors and compare these between two groups, namely
   - Group1, with a best -corrected visual acuity better than or equal to 6/18.
   - Group 2, with a best-corrected visual acuity worse than 6/18.

c) To compare the visual functions among the subgroups in Group 1 and Group 2,
   - Subgroup 1A, with BCVA $\geq$ 6/18 presenting for the first time.
   - Subgroup 1B, with BCVA $\geq$ 6/18 already using interventions
   - Subgroup 2A, with BCVA < 6/18 presenting for the first time.
   - Subgroup 2B, with BCVA< 6/18 already using interventions.

d) To provide necessary optical correction and ophthalmological interventions on the study patients; and

e) To document the effect of interventions on visual status of patients mainly the visual acuity and functional skills like reading and writing.

Review of Literature

REVIEW OF LITERATURE

According to the WHO (2011), Low Vision is defined as the best corrected visual acuity (BCDV) less than 6/18 to light perception or visual field of less than 10 degree in the better eye after the best possible correction[7].

According to WHO (2012) estimates, approximately 285 million people across the world live with low vision and blindness. Out of this estimation, 39 million people are blind and 246 million live with moderate to severe visual impairment. Of the latter, 145 million of the visually impaired people suffer from uncorrected refractive errors, where restoration of normal vision can be done with the help of optical devices such as spectacles[7].

In the 1260s, Marco Polo, who was an explorer, found that aged people in China were reading with the help of lenses which magnified the images. Four hundred years later, Descartes invented similar lenses in France. George Hellinger developed a program on low vision aids which were mainly optical in the Industrial Home for the Blind which is situated in the city of New York, in the 1950s. This was done 300 years after Descartes invention, and is known as Helen Keller Services for the Blind[8].Later, Gerald Fonda and Eleanor Faye, coined the term "low vision" [9].

The definition given by the Parliament of Britain in 1893 described blindness as "that level of visual impairment which prevents children from reading the normal school textbooks used by them"[9].

Von Rohr, in 1918, was responsible for designing a telescopic lens for Zeiss, and after this, the use of prisms for hemianopia were introduced[10] (Baunschnig, 1922). The working principles of low vision aids were conceptualised by about 1930s and the micro lens was introduced about 20 years later. In 1954, the first presentation of aids for the low vision people was organised by the International Congress of Ophthalmologists[11] (Goodrich & Arditi, 2000) and about 10 years later, a closed- circuit television was introduced first by the RAND Corporation[12] (Genensky, 1969). Visual aid techniques in the rehabilitation of low vision people, which include computers, is developing at a fast rate.

Magnitude of problem of low vision

Patient with low vision is one, who has impaired visual functions even after treatment, for example, after surgery in the eye or by refractive correction glasses/contact lenses. Such an individual has reduced visual acuity[13] i.e. less than 6/18 to light perception or a visual field of less than 10 degrees, but the patient is potentially able to use, vision for the planning or completion of a task[13]. Patients with low vision require special care and attention in their education and continuing eye care, in order to prevent further deterioration of their vision. Children with low vision are also in a complicated position from a socioeconomic point of view because they are not blind enough to be permitted to rehabilitation and social services. They also do not have enough sight to lead a life with good visual functions.

Visual disturbances that can be reported by patients are dimness of vision / haziness-distance and near, metamorphopsia- distorted images, photophobia-

abnormal sensitivity to light, colour distortions, field defects, night blindness, difficulties in dark adaptation, entoptic images- floaters/ flashes of light, reduced contrast sensitivity, asthenopia- eye strain and mental disturbances due to reduction in vision.

The major causes of low vision in young adults in developing countries are predominantly infective and nutritional causes. The other various ocular conditions that might lead to impairment of visual acuity are refractive errors like myopia/ hypermetropia/ astigmatism, cataract- developmental or traumatic, glaucoma- infantile or adult, corneal scars, degenerative myopia[14] etc.

Low vision is characterised by changes in visual functions such as decreased visual acuity, stereo acuity, contrast sensitivity, brightness perception, abnormal contour interaction. These visual functions can be reduced even in people with normal vision and are highly compromised in low vision[1]. These visual parameters determine the quality of vision that are used in daily tasks such as reading and writing, especially in the school and college years.

Amblyopia is one of the preventable cause of low vision. In amblyopia, the visual acuity is reduced. Interestingly, patients with amblyopia have improvement in the visual acuity by one or two lines when examined through a neutral density filter but patients with organic lesions have further worsening of visual acuity. Second, patients with amblyopia have reduced visual acuity when examined with multiple letters in the charts than by using single letter charts and this is named as crowding phenomenon.[15]

Snellen's distant visual acuity testing chart, which was developed by Herman Snellen in 1865, was an inexpensive and easy method to test acuity and was easily available and was accepted legally. The largest letter in the chart denoted a distance acuity of 20/200; any patient reading lesser than the first line was considered as severe visual impairment or legal blindness. This was because the Snellan acuity chart had only one letter "E" in the first line and it measure a distance vision of 20/200, the next two letters in the subsequent line represented the next level of vision (20/100). Thus it has been discovered that the Snellen's chart is not a valid test to assess the functional level of vision.

The first standardized chart for testing distant vision with Meter (M) notation was developed in the early 1950s, followed by the logMAR chart which was used in the 1970s. The chart was designed by Ian Bailey and Jan E Lovie-Kitchen at the National Vision Research Institute of Australia. The term "LogMAR" is derived from word Logaritham of the Minimum Angle of Resolution. The sizes of the letters in LogMAR chart progresses systemically in from one line to other line in geometric proportion. The size of the letter in each line is given as the logarithm to the base 10 of decimal visual acuity, so the 6/6 (20/20) line is LogMAR 0.00 The space between two lines and two letters will also change in proportion keeping the contour constant. For this reason it has been recommended that whenever visual acuity is measured, the logMAR chart is commonly used, particularly for research purposes[16]. (Bailey I L, Lovie J E, 1976).

Visual acuity is recorded by using the LogMAR chart in the following manner. Each letter has 0.02 log units score value. Since there are 5 letters per line, the total score for a line on the LogMAR chart represents a change of 0.1 log units for a line. The score is calculated as LogMAR visual acuity (VA) =0.1+ LogMAR value of the best line read-0.02 (number of letters read).

The advantages of LogMAR over other charts are that there are an equal number of letters per line, there is regular spacing between lines and letters, there is uniform progression in letter size and the final score is based precisely on the total of all letters read[16] (Bailey I L, Lovie J E, 1976).

Once the examiner has established the person's visual acuity for distance, it is important to measure visual acuity at near. It can be measured with word or text charts, characters, shapes or numbers. Near vision charts commonly used are meter (M) notation, reduced Snellen and Jaeger's charts.

Colour vision can be tested clinically by several devices, including Ishihara's pseudo- isochromatic plates, FM 100 Hue test, FM D15 Hue test and the anomaloscope. Based on Online Farnsworth D-15 colour blindness test[17] (2009), a computerized version of FM D 15 Hue test is available online. This test was introduced by Farnsworth in 1947. It aims to divide people into two groups : people who are slightly colour blind or not colour blind (these persons pass the test) and all other persons (these persons fail the test).

Colour blind individuals do not arrange colours in the correct order but parallel to one of the three confusion lines namely protan, deuteran and tritan.

Vingrys and King- Smith (1988,) developed a scoring method based on colour difference vectors. This test identifies the type and severity of colour blindness[18]. The type of colour blindness is quantified by the "confusion angle" and the severity is indicated by the "confusion index"[18].

The "confusion angle" identifies deficient colour vision of the individuals. Thus an angle greater than +0.7 degrees points towards a protan defect, one which is +0.7 and -55 a deuteran defect and a value below that suggests a tritan defect.Combining the values of the major radius and minor radius results in the Total Error Score (TES). The TES ranges from around 11 upto about 40 for marked deficiencies of vision.

The 'Selectivity index' indicates the parallelism of the confusion vectors to the confusion angle. This is the ratio of the major radius to the minor radius. Here it is classified into two types. The patient is diagnosed as either no colour deficiency or very low, if the ratio is below 2 and patients with colour deficiency will have high ratios more than 6.

The ratio between the major radius and the minor radius of a perfect arrangement is the 'Confusion index'. People with normal colour vision or slightly colour blind persons have a ratio below 1.2. The higher this value (above a ratio of 4), the more severe is the colour blindness.

Contrast sensitivity refers to the ability to identify slight changes in luminance which are not separated by definite borders in between two regions.Contrast refers to the inverse value of the least distinguishable contrast

(difference between light dark band or letter and back ground). The first low contrast letter was introduced in 1854.

The contrast (Weber fraction) for letters is defined as (Lt-Lb)/ Lb, where Lt and Lb are the luminance of the target and background, respectively. The contrast for sine wave gratings is the Michelson contrast = {Lmax- Lmin} / {Lmax+ Lmin}.Lmax indicates luminances of light bands and Lmin indicates luminances of dark bands.

The contrast sensitivity functions can be measured by plotting contrast sensitivity over high spatial frequencies. It shows a peak at intermediate spatial frequencies of 2-cycles / degree, with a rapid fall off at higher spatial frequencies and a gradual decline at lower frequencies, under photopic conditions.

Several factors may affect contrast sensitivity. With reference to refractive errors, the visibility at low spatial frequencies is not limited by the refractive property of the eye; refractive errors affect only the higher frequencies.

Interestingly, there is a definite decrease in contrast sensitivity with increasing age [19] (Campbell.FW, 1968). Early lenticular changes can reduce contrast sensitivity essentially for low spatial frequencies ; this decrease in contrast sensitivity is not related to the visual acuity. Contrast sensitivity is also found to be affected by various ocular diseases, such as glaucoma and amblyopia, and by systemic diseases, such as multiple sclerosis and pituitary adenoma[19] (Campbell. FW, 1968).

There are several types of contrast sensitivity deficits. There is increasing loss of contrast sensitivity at high spatial frequency is called as high frequency type of contrast sensitivity deficit, loss of contrast sensitivity for all spatial frequencies indicates level loss type and in patients with selective loss of contrast sensitivity, the deficits occur in a narrow band of spatial frequencies.

There are several ways of measuring contrast sensitivity. These include the Arden grating, Cambridge low contrast grating, Pelli- Robson contrast sensitivity chart and the Vistech chart.

LEA contrast sensitivity is a simple test easily understandable by children and used to check for contrast sensitivity in children with low vision, amblyopia and multiple disability. The LEA contrast sensitivity was named ater Dr.Lea Hyvarinen, a paediatric ophthalmologist who first used symbol charts followed by number charts to test contrast sensitivity in 1976. The visual information presented in low contrast settings is necessary for the process of visual communication[20] (Hyvarinen L, 2009). The test kit consists of 10 M LEA symbols in different contrast settings. The child is asked to identify the symbols, such as square, triangle, circle, home and apple from the highest contrast to the lowest at 3 meters first. If the child is not able to read all the 25 letters at 3 m, the distance is decreased to 2 meters, 1 meter and 0.5 meter. The number of symbols read at each distance is noted.

Stereopsis refers to the perception of depth and the three dimensional structure obtained on the basis of visual information in persons with normal

binocular single vision. It is measured in seconds of arc (1 deg= 60 min of arc; 1 min=60 secs)[21] (The normal spatial visual acuity is 1 min and normal stereo acuity is 60 secs. The lower the value, the better the acuity (Kanski, 2011).

Tests for stereopsis include theTNO and Frisby tests, which provide the most definite evidence of high -grade binocular single vision, the Titmus test, which gives more reliable evidence of stereopsis, and the Lang test.

TNO (The Netherlands Organisation) random dot test consists of randomly -distributed paired red and green dots which are viewed by red- green spectacles. The TNO cards consists of seven plates and within each plate the dots with particular colour forms the target shape and are displaced horizontally in relation to their paired dots of the other colour which gives retinal disparity from those outside the target. The test targets are visible to an individual with stereopsis while wearing red- green spectacles. First three plates are used to identify gross stereopsis and next four plates are used to quantify the stereopsis. The disparities measured range from 480 to 15 secs of arc tested at 40 cms. Most children are able to do this from about 4 years of age. The nomal stereopsis is considered to be less than or equal to 60 arc secs.

Visual field testing can be done by using static or kinetic perimetry. Bjerrum's screen is a type of kinetic perimetry. Here, the patient is seated at a distance of about 1 or 2 meters from the tangential screen and a moving stimulus of white test target of size 0.3 cm, 0.5 cm, 1 cm or 2 cms can be used. It involves the presentation of a moving stimulus from a non-seeing area to a seeing area

until it is noted. Then the stimulus is moved along various meridians (clock hours) and the point where the patient is able to perceive the target is recorded on the chart. By joining all these points, an isopter is plotted for that stimulus intensity. While evaluating low vision cases, first visual field is tested separately in each eye and finally the field is examined binocularly. Before prescribing for near vision, the location of the scotoma should be identified, that may indicate a need for eccentric viewing of training for the patients.

Normal binocular single vision involves the simultaneous use of both eyes with bifoveal fixation, so that each eye contributes to a common single perception of object. Conditions necessary for normal binocular single vision include normal routing of visual pathways with overlapping visual fields, binocularly- driven neurones in the visual cortex, normal retinal correspondence, accurate neuromuscular development and coordination and approximately equal image clarity and size for both eyes.

Binocular single vision is measured by the Synoptophore, which consists of 2 cylindrical tubes with a mirrored right- angled bend and a +6.50 D lens in each eye piece. This optically sets the testing distance equivalent to about 6 metres. The pictures are inserted in a slide carrier and they are moved in relation to each other and any adjustments are indicated on a scale. The synoptophore can measure horizontal, vertical and torsional misalignments simultaneously. The grades of BSV are simultaneous macular perception, fusion and stereopsis.

The near point of convergence (NPC) is the nearest point on which the eyes can maintain binocular fixation, measured with RAF (Royal Air Force) ruler. The RAF rule provides a binocular gauge to measure convergence, accomodation etc. The RAF rule is 50 cm long rule with a slider holding a four - sided rotating cube with each side presenting with different target. The first has a vertical line with a central dot for convergence fixation; next the others provide a limited number of lines of near- reading. A cheek rest is provided to insure consistency and height for the patient. Some studies[22] (Adler, 2007) have confirmed that near point of convergence when measured by Royal Air Force ruler gives accurate measurements. The objective NPC is measured by moving a target slowly along the rule towards the patient's eyes until fixation is lost in one eye and deviates laterally. The normal NPC should be nearer than 10 cms without undue effort.

The nearest point at which the accomodative target is seen clearly is called the near point of accomodation (NPA). The test is done using the RAF rule. The test is done on each eye first followed by both eyes together.From the NPA value recorded in the RAF rule, accomodative amplitude is calculated which is reduced in the case of amblyopia (Singmann and Matta, 2013). The near point of accomodation varies depending on the age, such as 7 cm at 10 years, 25 cm at 40 yrs and 33 cm at the age of 45 yrs, respectively[23] (Duke-Elder, Sir Stewart, 1969).

Physical accomodation occurs whenever there is deformation of lens happens during accomodation and it is measured in diopters. For example, if the

focusing power of the eye is increased by 1 D, the accomodation will increase by 1D. On the other hand, physiological accomodation refers to the contractile power of the ciliary muscle required to change the focusing power of the eye by 1D; it is measured in diopters. At a young age, both are equal. In old age, the lenticular capsule becomes stiffer, and hence, the quantum of physiological accomodation becomes less than the quantum of physical accomodation. This change is due to sclerosis of the lens and loss of elasticity of the zonules and ciliary muscles[24] (Duker, Jay S, 2008).

The reading rate refers to the speed and comprehension rate. The child should read a text school book used in his/ her grade and should read in his/her usual language. The current way of reading should be chosen; for example, using distance correction only, large print or school book size print with magnifier. The child should read as he /she does in school, for example, holding books in hand or on stand. A text should need a minimum of 5 minutes reading on average, and time should be measured using a watch with seconds. Five comprehension questions should then be asked after the reading and the reading speed and comprehension should be calculated as usual. The rate is the number of words read per minute which is calculated by the number of words read in the passage divided by the number of seconds spent in reading and then multiplied by sixty.

To measure the writing speed, the same text as used for reading speed should be used, and the text should be read to the client. The client is then asked to write the words /sentences for 3-5 minutes. The writing speed /min is

calculated by counting the number of letters. The patient should again use the glasses or device he /she normally uses while writing.

The treatment for low vision includes best glasses and low vision aids. A low vision aid refers to an optical device that improves or enhances residual vision by magnifying the image of an object at the retinal level. There are some - optical aids that may help in enhancing the visual performance. The types of optical low visual aids available include magnifying spectacles, hand magnifiers, stand magnifiers, telescopes and electronic magnifiers, (for example, closed - circuit television {CCTV}, low vision imaging system {LVIS} and V-max)[25].Non-optical devices include approach magnification, lighting, contrast enhancement, increasing size of the object to be viewed, magnifying mirror, writing and communication devices and orientation and mobility devices[25].

There are several studies reported in the literature on visual functions in refractive errors.

Luciana and de Figueinedo[26] (2011) evaluated the capacity to differentiate functional vision in children between low vision and normal vision group. In Group 1, there are 20 children with low vision and in Group 2, there are 20 children without low vision. According to this study, the total functional vision assessment median was low for the low vision group. In an earlier study, Khandekar[27] et al. (2010) evaluated the refractive status and visual functions of children with special needs in Oman and found that the prevalence of refractive errors in 70 children (aged 5 years) with special needs (group 1) and 175 normal

healthy first - grade students (group 2) was 58.5% and 2.9%, respectively; the risk of refractive error with reduced visual functions was significantly higher in group 1with hyperopia (>1.00 D), myopia (>1.00 D) and astigmatism (>1.00 D) in 18.6%, 24.3%, and 27.1%, respectively.

Karki[28] et al. (2006) conducted a study to investigate the prevalence of amblyopia in ametropes in a clinical set-up. In this study, individuals from 4-5 years age group to the young adults were selected. A total of 970 ametropic eye patients with visual acuity below 6/9 were included. Out of 970 ametropic eye patients a total of 56 (5.97%) patients have amblyopia. In this study, ametropic amblyopic patients with myopic astigmatism 31 (55.36%) were more common than other refractive errors and the distribution of ametropic amblyopia was more in males 32 (57%) than in females 24 (43%)

Karkhene[29] et al. (2003) conducted a study to detect colour vision deficit in axial high myopia in 40 patients aged 17-40 years with refractive error of 6.00 D or more with Farnsworth D-15. In this 26 eyes had colour vision defects including 24 eyes with tritan (blue-yellow) defect, 2 eyes with deutran (green) defect and one eye with protan (red) defect. The eyes with refractive error of more than -12.00 D or less had defective colour vision, and the eyes with less visual acuity less than 20/30 or more had defect in colour vision test.From this study he concluded that in high axial myopia there is colour vision defect, mostly with a tritan defect, and there is also a correlation between axial length of eyeball and defective colour vision.

Liou and Chiu[30] (2001) reported myopia and contrast sensitivity function of the study with 105 myopic eyes and 25 emmetropic eyes collected in corrected visual acuity of 20/20 or better. The myopic groups were divided into 4 groups. In group 1 and 2, there was no significant difference in contrast sensitivity between myopes and emmetropes. In group 3, statistically significant low contrast sensitivity at higher spatial frequencies was found for myopic subjects corrected only with spectacle lenses. In group 4, myopic subjects corrected with spectacles showed much reduction in contrast sensitivity functions at all frequencies. This study concludes that low and medium myopes with normal contrast sensitivity had no retinal dysfunction. The patients with early retinal function disruption will present with loss of contrast sensitivity before retinal changes occurs in severe myopic patients and this cannot be fully compensated by contact lens correction. For high myopes, contact lenses correction reduce the optical defocus and improve contrast sensitivity function in high spatial frequencies.

A study by Donnelly, Stewart and Hollinger[31] (2005) evaluated the prevalence and outcomes of visual disorders in children and young adults. It was found that hyperopia >3D (15.3%), myopia >0.5 D (10.8%) and astigmatism >1Dcyl (20.6%) refractive errors correlated with reduced contrast sensitivity.A study by Martin-Boglind (1991), Herse[32] et al. In 1992 and Donahue et al in 1999 found that an error as little as 1D can significantly influence the visual fields. Performance of visual field testing without spectacles resulted in reduced

peripheral visual field as well as reduction in contrast sensitivity along with slowed reaction time when compared with control subjects.

Ohno-Matsui[33] et al. (2011) conducted visual field examinations by Goldman kinetic perimetry for 492 eyes of 308 patients with high myopia (myopic refractive error >8D or axial length >26.5 mm) and followed up the patients for 5 years or more. Patients with posterior fundus changes were excluded. The study patients were classified as having significant field defect if 10% or more of field loss occurs and further loss of 10% or more during the follow-up period was classified as a significant progression. Significant fresh visual field defects developed in 13.2% of these selected highly myopic eyes during a mean follow-up of 11.6+/-5.5 years. The incidence of significant visual field defects was significantly higher in myopic eyes and later resulted in significant progression of defect in visual field. The progression of the visual field defects depends upon change in scleral curvature. (Ohno-Matsui, 2011).

Li S[34] et al (2014) conducted a study on stereoscopic visual acuity in types of ametropic amblyopia in 205 children with the average of 5.2 years including amblyopia in 65 cases of astigmatism, 30 myopia and 110 hyperopia. The distance and near stereoacuity were performed by synoptophore and random –dot stereoacuity test. Individuals with hyperopia have better central stereopsis and macular stereopsis, whereas children with astigmatism have significantly decreased stereoacuity. No difference was identified between the three types in children with severe amblyopia. The types and degrees of amblyopia were closely related with stereopsis. This study concluded that in mild and moderate

amblyopic eyes, children with astigmatism had the worst stereoacuity and there was significant difference ($p<0.05$) in stereoacuity between different refractive errors.

Walraven and Janzen[35] (1993) clinically evaluated and recorded stereopsis of 730 school children aged 4-18 yrs by using the TNO test for the early detection of amblyopia. Important findings were : all amblyopes were detected by the TNO test's recommended normal as 240 arc secs; the red- green anaglyphs used in the test did not create a issue for persons with a colour deficiency; the ability to discriminate depth improved by a factor of two over the age interval 4 to 12 years; a stereoacuity of less than or equal to 120 sec arc was a good predictor of normal or correctable normal vision and there was a greater chance of disturbed binocular vision; and 75% of amblyopes remained amblyopic, possibly because of delayed detection, with 60% of the amblyopes in the population examined not being identified before the age of 5 years.

Some years ago, Chang[36] et al. (2007) studied screening of preschool children for amblyopia with uncorrected vision and stereopsis tests in Eastern Taiwan. This study aimed at evaluating the validity of uncorrected distant vision, near vision and random dot stereopsis for screening amblyopia.5232 children were included, screened by distance visual acuity and near visual acuity values. It was concluded that screening for amblyopia by using visual acuity tests or random dot stereopsis test alone did not display a high sensitivity but simultaneous testing of distant visual acuity and stereopsis test elevated the sensitivity while preserving the specificity.

In a retrospective study, Taylor[37] et al. (2012) noted that 73% of children were successfully treated with patching, but that this figure dropped to about 50% of children after 3 years. About 25% of successfully- treated children experienced a recurrence within a year of tailing off of treatment; this was more likely to occur if treatment was stopped abruptly. Repka[38] et al. (2009) conducted a study on contrast sensitivity following treatment of amblyopia like patching versus application of atropine eye drops in moderate amblyopic eyes. The contrast sensitivity was measured by using Pelli- Robson charts in 86 subjects (mean age 10.3 years) who at 3 to 6 years of age. Visual acuity in the amblyopic and fellow eyes at the time of the exam were 0.17 logMAR units and -0.04 logMAR units, respectively. There was a statistically significant difference in mean identification score of contrast letter, and this was slightly more in the amblyopic eye than in the fellow eye (1.75 versus 1.78).

In a study by Carney[39] et al. (1997), the main structural difference between hyperopic and myopic eyes was found to be the axial length, which was higher for myopic eyes. Axial length (AL) was measured by the IOL Master in 24 myopic and 22 hyperopic eyes and these eyes did not show any ocular disease or condition apart from the corresponding ametropia. Both groups were age-matched, being 30.5+/- 3.8 yrs (range 26-39 yrs) for the myopic and 30.3+/- 5.2 yrs (range 23-40 yrs) for the hypermetropic group. The spherical equivalent was higher (from -0.8 to -7.6 D) for the myopic group than for the hypermetropic group (+0.5 to +7.4 D). Astigmatism was less than 2.5D for all the subjects. The axial length of hyperopic eyes (22.62+/- 0.76 mm) was significantly lower than

the axial length of myopic eyes (25.16+/-1.23). There was statistically significant linear correlation of axial length with spherical equivalent of refractive error, and hyperopic eyes tended to shorten with increasing spherical equivalent (Carney et al, 1997). Similarly, the axial length/ apical radius of curvature of the cornea was significantly higher in the myopes (3.2+/-0.2) than in the hypermetropic group (2.8+/-0.1). There was statistically significant correlation between AL/CR and spherical equivalent of refractive error. ($p<0.001$) (Carney et al, 1997). Larger amounts of spherical aberrations were also noted in hyperopic eyes compared to moderately myopic eyes. The authors opined that the corneal radius of curvature and asphericity causes significant differences in spherical aberration and it was due to ocular growth (hyperopic eyes were smaller and more spherical whereas myopic eyes tended to flatten more in the periphery than in the central cornea). As a result of increased corneal spherical aberration in hyperopic eyes, a total spherical aberration was found to be significantly higher in hyperopia than in myopia with similar absolute refractive error and age.

A study by Lueck[40] et al. (2003) showed that children with low vision need minimum three times the acuity reserve to read properly. So patients with low vision need larger print sizes to gain the optimum acuity reserve. A study by Lovie-Kitchin[41] et al. (2001) showed that acuity reserve between 2.5:1 to 7:1 was necessary to achieve maximum reading rate. Patients with lower visual acuities tended to achieve maximum reading rate with less acuity reserve. These authors considered age as a better predictor of reading rate than near visual

acuity in children with low vision. A study by Farmer and Morse[42] in 2007 compared between 2 groups of children. Large print sizes were given to the first group and magnifiers were given to second group of children for reading. The results showed that the first group had an increase in reading speed rates but no significant increase in comprehensive skills. The second group of children showed an increase in their reading speed rates as well as an increase in their reading comprehensive skills.

According to Leat and Woodhouse[43] (1993), the best predictor of reading speed was contrast sensitivity. Based on a study of 30 adult subjects, the authors concluded that contrast sensitivity at 0.5c/deg was correlated with reading performance and contrast sensitivity. The patients with low vision had poorer reading speed at high spatial frequencies of contrast sensitivity than at the lower spatial frequencies. These authors concluded that visual reading in children with low vision depends on visual requirements in terms of acuity (or magnification), contrast sensitivity and visual field.

In a study by Legge[44] et al (1985), 141 adults with low vision were included. Visual field was examined by Goldmann perimeter or tangent screen. If the subject had a scotoma that covered all or part of the central 5 degree of the visual field he/ she was considered to have central visual field loss which was associated with a slow reading speed. The majority (74%) of slow readers were found to have central visual field loss.

G.Burggasser[45] et al (2005) conducted a study on monocular and binocular reading performance in children with microstrabismic amblyopia. The reading performance of 20 children with microstrabismic amblyopia and 20 normal sighted children were compared by using standard reading charts for reading acuity and speed. In this study, binocular reading speed was 200 words/min for controls, 173 words/min for binocular reading speed in amblyopic children but no difference in visual acuity and reading acuity.For monocular reading, impairment was found in the amblyopic eye than the sound eye. This study concluded that functionally relevant reading impairment was present in amblyopic patients eventhough patients had normal binocular visual acuity and reading acuity.

A putative relationship between writing skills and visual- motor control was assessed in 42 students with low vision and 26 normal-sighted students Atasavum Uysal[46], 2012). The authors administered the Bruininks- Oseretsky Proficiency Function Test writing subset, and a legibility assessment. Significant differences were found between the groups in writing speed, legibility, and visual motor control. Visual motor control was correlated with both writing speed and legibility. Students diagnosed as low vision had poorer performance in handwriting, with slower writing speed. From this study, it was concluded that patients with low vision had correlation between visual motor control and writing.

Singman and Matta[47] (2013) conducted a study of association between accomodative amplitudes (AA) and amblyopia. The Grand Seiko auto refractor

(GSAR) was used to measure accomodative amplitudes in children with amblyopia and the result was confirmed by using subjective and objective tests which includes the minus lens method, the near point of convergence by using Prince Rule, and retinoscopy. The accomodative amplitude was reduced in fifty-two children at 1/3 of a meter wearing their glasses correction during examination.

Ruth E. Manny, Karen D.Fern[48] (2011) conducted a study on changes in fusional vergence, phoria and near point of convergence in myopic children in 114 individuals, aged 7-13 years and followed up annually for 10 years. During follow-up, measurements like refractive error for distance and near, prism bar fusional vergence range, near point of convergence were measured.After 10 years, the distance and near base out was decreased from 20 pd and 30 pd to 5.6 pd and 9.4 pd. This study concluded that for myopic children, the near point of convergence ranges decrease for both distance and near vision viewing as near phoria becomes more exophoric.

Adler[49] et al (2007) conducted a study on measurement of NPC by using different target types and RAF rule. Five targets were used to measure the NPC, namely, pencil tip, finger tip, penlight, N5 letter and vertical line target on the RAF rule. No significant difference was found in NPC measurements by different target types. The RAF rule was found to significantly influence the NPC obtained. There was significant difference in NPC measurements between RAF line target and other targets, where the former resulted in NPC values of

1.9 times as much as those obtained with other targets. The effect of the RAF rule was more apparent for more receded NPC points. (Adler et al, 2007).

Mohindra and Molinari [50] (1980) studied a three step approach to further evaluate convergence insufficiency in patients. First, the NPC was measured with a penlight and second, the NPC was measured with a penlight and a red filter over one eye or with a red-green filter and lastly the NPC was measured with an accomodation target. The results from these three measurements were compared. In such cases, the measurement with the accomodative target would be found to be near normal or better than the non- accomodative penlight target. Patients having good binocular vision for near would get similar results from the three tests compensating any anomaly with accomodation if present.

A study by Cotter[51] et al. (2007) provided an optometric perspective on the management of hyperopia in children without strabismus or amblyopia. These authors concluded that variations in prescribing patterns for childhood hyperopia occur within optometry and within ophthalmology. They opined that there are also differences in prescribing philosophies between the two professions. These differences are probably due to a greater level of concern, possibly more so among optometrists, about associated vision functions such as accomodation, vergence and stereopsis as well as concern about the potential impact of uncorrected hyperopia on reading and school performance.

Sethi and Kartha[52] (2000) studied the prevalence of refractive errors in school children (12-17 years). In the study, 417 students were found to have

refractive errors. Of these 196 were females and 221 were males. There was no significant difference between frequency of occurrence of refractive errors among males and females. In this study, myopia was found in 265 cases, hypermetropia in 47cases and astigmatism in 85cases. The refractive errors was found to be 25.3% which included 63.5% myopia, 11.2% hypermetropia and 20.4% astigmatism and this study concluded that myopia was more common in children. (Sethi and Kartha, 2000).

Brady[53] et al. (2012) studied visual functions in patients with refractive errors after correction of distance refractive error with ready- made spectacles (RMS) and custom made spectacles (CS). In this study, complete refraction was done in 363 adults aged 18-45 yrs with >1 D of uncorrected refractive error and they were randomized to receive custom spectacles (full sphero- cylindrical correction) or ready- made spectacles based on the spherical equivalent. The visual function of the patients and quality of life improvement, participant satisfaction were estimated. The Rasch scores for visual quality of life increased from 1.14 to 4.37 logits in the RMS group, and from 1.11 to 4.72 logits in the CS group. Mean satisfaction with vision at one- month follow up also increased by 1.83 points on a 5- point Likert scale in the RMS group and 2.04 points in the CS group.

Huang[54] et al (2014) conducted stereoacuity tests in 11 observers (21.1+/- 5.1 years) with anisometropic or ametropic amblyopia. They were trained to judge depth in 10-13 sessions. Red -green glasses were used to present 3 different texture anaglyphs with different disparities but with a fixed exposure

duration. Stereoacuity test and visual acuity were assessed with the Tumbling E chart before and after training. This study showed significantly reduced disparity threshold from 776.7" to 490.4" ($p<0.01$) and improved stereoacuity from 200.3" to 81.6"and also the patient had significantly improved visual acuity from 0.44 to 0.35 logMAR in the amblyopic eye after training.

Wallace[55] et al. (2007) studied treatment of bilateral refractive amblyopia in children about 3-10 years of age.113 children with previously untreated bilateral refractive amblyopia were corrected with spectacles. Bilateral refractive amblyopia was defined as best corrected visual acuity of 20/40 to 20/400 with 4.00D or more of hypermetropia, 2.00 D or more of astigmatism, or both in each eye. Best corrected binocular and monocular visual acuities were measured at baseline and at 5, 13, 26 and 52 weeks In this study, it was concluded that the mean binocular visual acuity improved from 0.5 logMAR at baseline to 0.11 logMAR at one year.

Patients & Methods

MATERIALS AND METHODS

This prospective, comparative study was done to compare the visual functions in individuals with normal vision and those with low vision and also to document the improvement in the subjective and objective visual parameters in children and young adults in whom interventions were made.

All patients aged 5-30 years presenting with refractive error at the out-patient department of the Institute of Ophthalmology, Joseph Eye Hospital, Tiruchirappalli were assessed for possible inclusion in the study from August 2014- October 2014 and reviewed after 6 months. Ethical clearance was obtained from the Institutional Ethics Committee, Institute of Ophthalmology, Joseph Eye Hospital (IOJEH), Tiruchirapalli. Informed consent was obtained from the parents or guardian who accompanied the children. The nature and purpose of the study were explained to the participants /parents.

INCLUSION CRITERIA

1. Patients in the 5-30 years age group ;
2. Literate patients ;
3. Patients with informed consent for participation in the study ;
4. Patients willing for follow-up study; and
5. Ametropic amblyopia.

EXCLUSION CRITERIA

Patients were excluded from the study if they had even one of the following :

1. Strabismus / anisometropic amblyopia ;
2. Refractive errors <0.5 D (sphere / cylinder) ;
3. Nystagmus ;
4. Any previous ocular surgeries ;
5. Any ocular pathology (in the cornea, retina, lens).

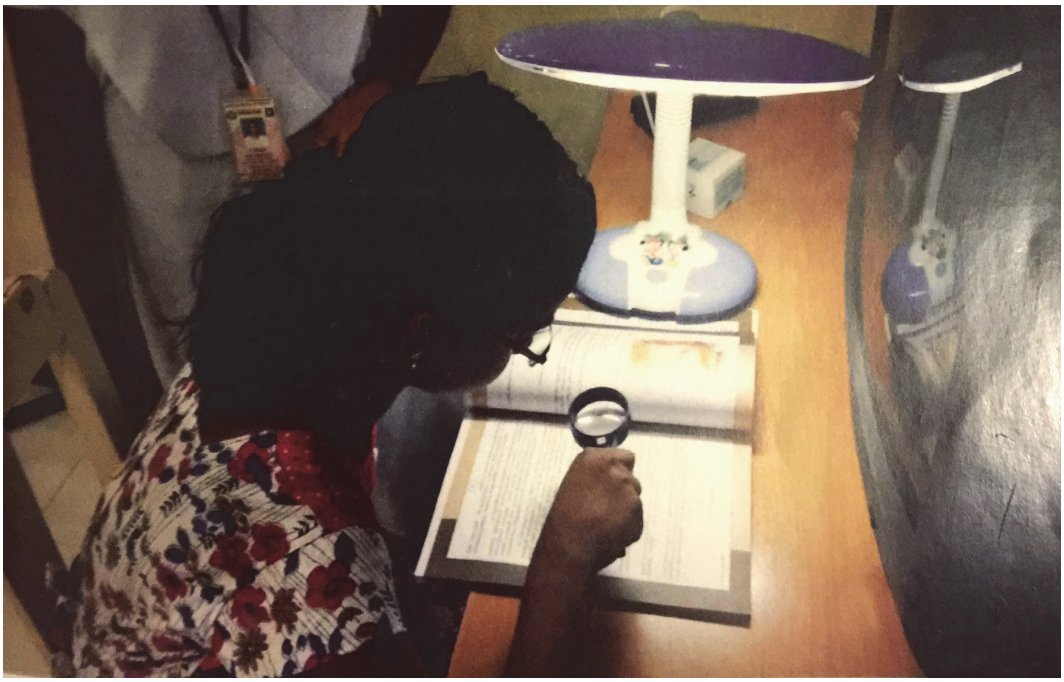
The patients were divided into two groups. Group 1, were those with best corrected visual acuity (BCVA) > 6/18 (in both eyes) (50 patients), Group1 subgroup A consisted of those presenting for the first time while subgroup B consisted of those already using interventions. Group 2, were those with (BCVA) <6/18 (in both eyes) (50 patients); Group 2 subgroup A consisted of those presenting for the first time while Group 2 subgroup B consisted of those already using interventions.

All eligible patients underwent a complete clinical and visual function assessment and were prescribed interventions. Clinical and visual function assessment include examination of the anterior segment by slit-lamp biomicroscopy and posterior segment by fundus examination, presenting and best corrected visual acuity testing by logMAR charts for both distance and near vision; refraction; contrast sensitivity testing by Lea's low contrast numbers; visual field testing by Bjerrums; colour vision by Farnsworth D 15; testing of visual skills such as reading and writing speed, stereopsis by TNO cards and binocular single vision parameters by synoptophore, near-point of accommodation and near-point of convergence by RAF ruler.

Interventions prescribed included prescription of distance and near correction, optical, non-optical devices and environmental modifications. All cases were reviewed after 6 months and presenting and BCVA, and visual skills like reading and writing speed were evaluated at follow up.

Data compiled included age, gender, duration of complaints, previous use of best glasses and duration of use, type of refractive error, uncorrected and best corrected distance and near visual acuity values, colour vision, stereopsis, binocular single vision, visual fields, contrast sensitivity, visual skills like reading speed, writing speed, comprehension and mobility. The visual functions of the patients were compared and evaluated between the groups. The components of visual function and visual skills with the groups was also correlated and compared. The results obtained from the study were analysed.

Assessment of Stereopsis using TNO Test Card



Low Vision Intervention

Assessment of Contrast Sensitivity using LEA Colour Contrast 10 M test

Assessment of Reading and Writing Skills

Results

RESULTS

The current study on visual functions in children and young adults with refractive errors was performed at the Low Vision Department of Institute of Ophthalmology Joseph Eye Hospital, Tiruchirapalli, Tamilnadu.

The study population was enrolled over a period of three months (August 2014 to October 2014) with a detailed evaluation of uncorrected and best corrected distant and near visual acuity, contrast sensitivity, colour vision, stereopsis, binocular single vision, near point of accommodation, near point of convergence and functional skills like reading and writing skills, being performed at the time of enrolment and again after 6 months.

1. Sample size

Eligible patients enrolled in the study were sought to be categorised into two main groups (two arms) based on best- corrected visual acuity (BCVA) at the time of initial presentation, namely, with BCVA ≥ 6/18{better than or equal to 6/18) or with BCVA< 6/18. Given a population size of 150, a response distribution of 70%, a margin of error of 5% and a confidence level of 95%, a recommended sample size of 103 individuals per arm of the study was calculated (calculated online at www.raosoft.com, accessed on August 20, 2014).

Due to various constraints (limited time duration of the study, reluctance of patients to participate), it was finally possible to enroll only a total of 100 individuals in the study, with 50 individuals in each arm of the study.

2. Study population

It was finally possible to enroll 100 individuals (58 males and 42 females) ranging in age from 5 to 30 years. These individuals were categorised into two groups, with each of the main groups having two subgroups as:

- Group 1: Individuals (n_1=50) with BCVA ≥ 6/18
    - Subgroup 1A (25) = Those presenting for the first time.
    - Subgroup 1B (25) = Those who are already using interventions.

- Group 2: Individuals (n_2=50) with BCVA < 6/18
    - Subgroup 2A (25)= Those presenting for the first time
    - Subgroup 2B (25)= Those who are already using interventions.

3. Demographic Aspects of the Study Population

3.1 Age of the individuals enrolled

Mean age of the individuals enrolled in Group 1 was 15.96 ± 6.45 years and that in group 2 was 12.78 ± 6.67 years. This difference was statistically significant [Mann-Whitney U test; (U= 850); P=0.006).

The mean age of the individuals studied was 15.8 ± 7.1 years in Group 1A and 16.2± 5.8 years in Group 1B, 10.0 ± 5.9 years in Group 2A and 15.0 ± 6.7 years in Group 2B. The difference in mean ages between subgroups 1A and 1B was not statistically significant, while the difference in mean ages between subgroups 2A and 2B was statistically significant (U=170; P=0.006) (Table1, Fig 1).

Table 1: Mean ages of individuals enrolled in the current study.

Group (no.of individuals)	Mean Age (yrs)	Statistical analysis (Mann-Whitney 'U' test)	Subgroups (100)	Mean Age (yrs)	Statistical Analysis (Mann-Whitney 'U' test)
Group 1 (50)	15.96 ± 6.45	Group 1 vs Group 2 U=850 P=0.006	1A (25)	15.8 ± 7.1	Group 1A vs 1B U=292, P=0.690
			1B (25)	16.2 ± 5.8	
Group 2 (50)	12.78 ± 6.67		2A (25)	10.0 ± 5.9	Group 2A vs 2B U=170, P=0.006
			2B (25)	15.0 ± 6.7	

Subgroup 1A=. Individuals (n=25) with BCVA ≥ 6/18 presenting for the first time.

Subgroup 1B= Individuals (n=25) with BCVA ≥ 6/18 already using interventions.

Subgroup 2A=Individuals (n=25) with BCVA < 6/18 presenting for the first time.

Subgroup 2B=Individuals (n=25) with BCVA< 6/18 already using interventions.

3.2 Gender of the individuals enrolled

There were 22 males and 28 females in Group 1 (11 males and 14 females each in Group 1A and in 1B), 36 males and 14 females in Group 2 (19 males and six females in Group 2A and 17 males and eight females in Group 2B). The difference between the proportions of males and females in Group 1 and 2 was statistically significant (Table 2) (Chi-square test $\boldsymbol{x}^2$ (d.f=1)=8.046, P=0.005). However, there was no statistically significant difference between the proportions of males and females in the subgroups (Table 2, Fig 2).

Table 2: Gender distribution of the individuals enrolled.

Groups (no.of individuals)	Gender		Statistical analysis (Chi-square)	Subgroups (100)	Gender		Statistical analysis (Chi-square)
	Male	Female			Male	Female	
Group1 (50)	22	28	{ x^2 (d.f=1) =8.046, P=0.005}	1A (25)	11	14	{x^2 (d.f=1)=0.00, P=1.000.}
				1B (25)	11	14	
Group 2 (50)	36	14		2A (25)	19	6	{x^2 (d.f=1)=0.397, P=0.53
				2B (25)	17	8	

Subgroup 1A=. Individuals (n=25) with BCVA ≥ 6/18 presenting for the first time.

Subgroup 1B= Individuals (n=25) with BCVA ≥ 6/18 already using interventions.

Subgroup 2A=Individuals (n=25) with BCVA < 6/18 presenting for the first time.

Subgroup 2B=Individuals (n=25) with BCVA< 6/18 already using interventions.

3.3 Diagnosis of refractive errors in both eyes of the individuals enrolled in the current study.

In group 1, twenty six (52%) patients had myopia, one (2%) had hypermetropia, twelve (24%) had simple myopic astigmatism, nine (18%) had compound myopic astigmatism, two (4%) had compound hypermetropic astigmatism in both eyes.

In group 2, ten (20%) patients had myopia, four (8%) had hypermetropia, eight (16%) had simple myopic astigmatism, twenty six (52%) had compound myopic astigmatism, one (2%) had compound hypermetropic astigmatism, one

(2%) had mixed astigmatism in both eyes. These differences were statistically significant (Yates' correction was applied because atleast one expected frequency was <1, Yates'{χ^2 =14.8; Yates'P=0.01} (Table 3).

Myopia was present in 10 (40%) of 25 individuals in group 1A and in 16 (64%) of 25 individuals in group 1B; this difference was not statistically significant (χ^2 [d.f=4]=8.4;P=0.83). Compound myopic astigmatism was present in 11 (44%) of 25 individuals in group 2A and in 15 (60%) of 25 individuals in group 2B; this difference was not statistically significant (χ^2 [d.f=5]=6.2;P=0.3) (Table 3, Fig 3).

Table-3. Refractive errors in both eyes of the individuals enrolled in the current study.

Type of refractive errors	No. of individuals affected in		Statistical significance
	Group 1	Group 2	
Myopia	26	10	Yates'{χ^2 =14.8, Yates' P=0.01.
Hypermetropia	1	4	
Myopic astigmatism	12	8	
Compound myopic astigmatism	9	26	
Compound hypermetropic astigmatism	2	1	
Mixed astigmatism	0	1	

Yates' correction was applied atleast 1 expected frequency was <1.

Group 1= Individuals (n=50) with BCVA ≥ 6/18.

Group 2=Individuals (n=50) with BCVA < 6/18.

3.4. Evaluation of mean spherical equivalent in both eyes of individuals enrolled.

The mean spherical equivalent was -1.85±1.94 in Group 1 and -5.9±7.85 in Group 2; this difference was statistically significant (Mann- Whitney U test [U=679]; P<0.001).

The mean spherical equivalent was -1.2±2.85 D in subgroup 1A, -2.50±2.75 D in subgroup 1B (Table 4); this difference was statistically significant (Mann-Whitney 'U' test, U=173.5; P=0.007). The mean spherical equivalent values in subgroups 2A and 2B were -5.9±7.8 D and -5.9±8.5 D, respectively (Table 4); this difference was not statistically significant (Mann-Whitney 'U' test, U=279.5; P=0.5) (Table 4).

Table 4: Mean spherical equivalent in both eyes of the individuals enrolled in the current study

Groups (no.of individuals)	Mean Spherical Equivalent (dioptres)	Statistical analysis (Mann-Whitney 'U' test)	Subgroups (no.of individuals)	Mean Spherical Equivalent (dioptres)	Statistical analysis (Mann-Whitney 'U' test)
Group 1 (50)	-1.85±1.94	U=679, P<0.000	1A (25)	-1.2±2.85	U=173.5, P=0.007
			1B (25)	-2.50±2.75	
Group 2 (50)	-5.9±7.85		2A (25)	-5.9±7.8	U=279.5, P=0.5.
			2B (25)	-5.9±8.5	

Subgroup 1A=. Individuals (n=25) with BCVA ≥ 6/18 presenting for the first time.

Subgroup 1B= Individuals (n=25) with BCVA ≥ 6/18 already using interventions.

Subgroup 2A=Individuals (n=25) with BCVA < 6/18 presenting for the first time.

Subgroup 2B=Individuals (n=25) with BCVA< 6/18 already using interventions.

4. Interventions prescribed for individuals enrolled in the study

In Group 1 and 2, distance vision correction was prescribed to all patients except three patients in subgroup 1B and one patient in subgroup 2B, who were advised to continue using the same spectacles. In addition, patients in Group 2 were advised to use non-optical aids/ for near work (Table 5, Fig 4).

In Group 1A, new glasses were prescribed for all (100%)25 patients while in Group 1B, new glasses were prescribed for 22 (88%) of 25 patients; this difference was not statistically significant (Yates'{χ^2 =1.42; P=0.23). In Group 2A, new glasses were prescribed for all (100%)25 patients, while in Group 2B, new glasses were prescribed for 24 (96%) of 25 individuals; this difference was not statistically significant ({χ^2 [d.f=1]=1.0;P=0.3).

None of the patients in Group 1 were provided Low vision aids. There was no significant difference in the prescription of low vision aids between Group 2A and 2B (({χ^2 [d.f=4]=7.754, ;P=0.2).

Table 5. Interventions prescribed to the individuals enrolled in the study.

Interventions	Group 1		Statistical analysis	Group 2		Statistical analysis
	1A	1B		2A	2B	
Glasses	25	22	Yates'=1.42, P=0.23.	25	24	{χ^2 [d.f=1]=1.020, P=0.312}
Same glasses	0	3		0	1	
Low vision aids						
CCTV	0	0	No significant difference.	0	2	(χ^2 (d.f=4)=7.754, P=0.2
Magnifiers	0	0		1	1	
Lamp	0	0		2	1	
Telescope	0	0		2	0	
Bifocals + Lamp	0	0		3	0	

5. CLINICAL VISUAL ASSESSMENT (Assessment of visual functions)

(As the difference in clinical visual parameters in between the eyes are minimal, the clinical visual evaluation is considered for both eyes together).

5.1. Evaluation of best corrected distant visual acuity (BCDV) of both eyes of individuals enrolled:

The mean BCDV (logMAR units) was 0.03±0.09 in Group 1 and 0.61±0.13 in Group 2 (Table 6);this difference was statistically significant (Mann- Whitney 'U' test ;U=679, P<0.001).

The mean BCDV (logMAR units) was 0.05 ± 0.12 in subgroup 1A and 0.00 ± 0.0 in subgroup 1B; this difference was statistically significant (Mann-Whitney 'U' test, U=262.5; P=0.04).

The mean BCDV (logMAR units) was 0.65 ± 0.15 in subgroup 2A and 0.57 ± 0.09 in subgroup 2B (Table 6); this difference was statistically significant (Mann-Whitney 'U' test;U=199.5, P=0.02). In both the groups comprising of patients with normal and low vision, review patients had a statistically significant better acuity than new patients (Table 6, Fig 5).

Table 6: Evaluation of best corrected distant visual acuity of both eyes of the individuals enrolled in the study

Group (no. of individuals)	Mean BCDV (logMAR units)	Statistical analysis (Mann-Whitney 'U' test)	Sub groups (no.of individuals)	Mean BCDV (logMAR units)	Statistical analysis (Mann-Whitney 'U' test)
Group 1 (50)	0.03 ± 0.09	Group 1 vs 2 U=0.00, P=0.000	1A (25)	0.05 ± 0.12	Group 1A vs 1B U=262.50, P=0.039
			1B (25)	0.00 ± 0.00	
Group 2 (50)	0.61 ± 0.13		2A (25)	0.65 ± 0.15	Group 2A vs 2B U=199.50, P=0.020
			2B (25)	0.57 ± 0.19	

BCDV=best corrected distant visual acuity.

Subgroup 1A=. Individuals (n=25) with BCVA ≥ 6/18 presenting for the first time

Subgroup 1B= Individuals (n=25) with BCVA ≥ 6/18 already using interventions.

Subgroup 2A=Individuals (n=25) with BCVA < 6/18 presenting for the first time

Subgroup 2B=Individuals (n=25) with BCVA< 6/18 already using interventions.

5.2 Evaluation of best corrected near vision (BCNV) of both eyes of the individuals enrolled in the study

The mean BCNV (logMAR units) was 0.63 in Group 1 and 1.22±0.73 in group 2 (Table 7); this difference was statistically significant (Mann-Whitney 'U' test, U=400; P<0.001).

There were no statistically significant differences between subgroups 1A and 1B and also no statistically significant differences between subgroups 2A and 2B with reference for mean BCNV values (Table 8).

Table 7: Evaluation of best corrected near vision (BCNV) of both eyes of the individuals enrolled in the current study

Group (no.of individuals)	Mean BCNV (logMAR units)	Statistical analysis (Mann-Whitney 'U' test)
Group 1 (50)	0.63±0.00	Group 1 vs Group 2 U=400 ;P<0.001
Group 2 (50)	1.22 ±0.73	

Group 1= Individuals (n=50) with BCVA ≥ 6/18.

Group 2=Individuals (n=50) with BCVA < 6/18.

Table-8: **Evaluation of clinical parameters in both eyes of the individuals within the subgroups enrolled in the study**

Clinical parameters (In both eyes)	Subgroups					Statistical analysis (Mann-Whitney 'U' test)
	1A (25)	1B (25)	Statistical analysis (Mann-Whitney 'U' test	2A (25)	2B (25)	
BCNV (logMAR units)	0.63±0.0	0.63±0.0	M=312.50, P=1.000	1.33±0.93	1.11±0.43	M=312.500 P=1.000
Confusion angle (degrees)	70.08±7.0	68.0±7.5	M=259.50 P=0.293	20.69±61.21	21.6±60.4	M=301 P=0.823
Contrast sensitivity	18.4±5.5	18.6±3.4	M=298 P=0.768	6.60±5.14	7.40±5.79	M=289.5 P=0.644
Stereopsis (arc secs)	81.6±42.0	72.0±24.4	M=285 P=0.472	199.2±156.5	192.2±117.5	M=290 P=0.284
Fusional range (degrees)	15.04±2.5	14.5±2.4	M=292 P=0.686	15.96±3.7	15.68±3.5	M=288 P=0.629
NPC (cms)	11.4±2.2	11.0±1.9	M=234.5 P=0.116	9.32±2.4	10.32±2.2	M=234.5 P=0.116
NPA (D)	11.4±2.2	11.0±1.9	M=256 P=0.257	9.12±2.6	9.92±2.5	M=256 P=0.257

BCNV=best corrected near visual acuity.

NPC=near point of convergence.

NPA= near point of accommodation.

Subgroup 1A=. Individuals (n=25) with BCVA ≥ 6/18 presenting for the first time

Subgroup 1B= Individuals (n=25) with BCVA ≥ 6/18 already using interventions.

Subgroup 2A=Individuals (n=25) with BCVA < 6/18 presenting for the first time

Subgroup 2B=Individuals (n=25) with BCVA< 6/18 already using interventions.

5.3 Evaluation of Colour Vision in both eyes of the individuals enrolled in the study.

The mean confusion angle was 69.04±7.30 (degrees) in Group 1 and 21.13±60.16 in Group 2 (Table 9); this difference was statistically significant (Mann-Whitney'U' test;U=731.5;P<0.001).

The mean confusion angle was 70.08 ± 7.0 in 1A, 68.00 ± 7.5 in 1B, 20.69 ± 61.21 in 2A and 21.57 ± 60.36 in 2B subgroups. There was no statistically significant difference between subgroups 1A and 1B (U=259.50, P=0.293) or between subgroups 2A and 2B (U=301, P=0.823) (Table 8).

Table-9: Evaluation of the mean confusion angle in both eyes of the individuals enrolled in the current study

Group (no.of individuals)	Mean confusion angle (degrees)	Statistical analysis (Mann-Whitney 'U' test)
Group 1 (50)	69.04± 7.30	Group 1 vs Group 2 U=731.5, P<0.001.
Group 2 (50)	21.13±60.16	

Group 1= Individuals (n=50) with BCVA ≥ 6/18.

Group 2=Individuals (n=50) with BCVA < 6/18.

In group 1, colour vision was normal in all the patients and there was no significant difference between the subgroups. In group 2, six patients in 2A and 10 patients in 2B had normal colour vision, 12 in 2A and nine in 2B had protan defect, three in 2A and three in 2B had deuteran defect and four in 2A and three in 2B had tritan defect (Fig:1); These differences were not statistically significant by Chi-square test {χ^2 (d.f=3) =1.6, P=0.7} (Fig 6).

5.4 Evaluation of contrast sensitivity in both eyes of the individuals enrolled in the study.

The mean number of letters read in the contrast sensitivity chart at 3metres was 18.50±4.50 letters by Group 1 individuals and 7.00±5.43 letters by Group 2 individuals (Table10; this difference was statistically significant (Mann-Whitney 'U' test, U=153;p<0.001).

The mean number of letters read in the contrast sensitivity chart at 3 meters was 18.40 ± 5.47 letters by subgroup 1A individuals, 18.60 ± 3.39 letters by individuals in subgroup 1B, 6.60 ± 5.14 letters by individuals in subgroup 2A and 7.40 ± 5.79 letters by individuals in subgroup 2B (Table 8). These differences between subgroups 1A and 1B values were not statistically significant (U=259.5;P=0.3) and the differences between subgroup 2A and subgroup 2B values were also not statistically significant (U=301; P=0.8) (Table 8, Fig 7).

Table 10: Evaluation of mean contrast sensitivity in both eyes of the individuals enrolled in the current study

Group (no. of individuals)	Mean contrast sensitivity	Statistical analysis (Mann-Whitney 'U' test)
Group 1 (50)	18.50±4.50	Group 1 vs Group 2 U=153 ;P<0.001
Group 2 (50)	7.00±5.43	

Mean contrast sensitivity is measured as number of letters read in the chart at 3 Meters distance.

Group 1= Individuals (n=50) with BCVA ≥ 6/18.

Group 2=Individuals (n=50) with BCVA < 6/18.

5.5 Evaluation of Stereopsis of the individuals enrolled in the study.

The mean stereopsis was 76.80±34.37 arc secs in Group 1 and 195.6±137.04 arc secs in Group 2 (Table 11); this difference was statistically significant (Mann-Whitney'U' test; U=490; P<0.001).

In the subgroups, the mean stereopsis was 81.60 ± 42.00 arc secs in 1A and 72.00± 24.49 in 1B, 199.20 ±156.57 in 2A and 192.00 ± 117.47 in 2B. There was no statistically significant difference between the mean stereopsis values in subgroups 1A and 1B (U=285, P=0.472), and also no statistically significant difference in mean stereopsis values between subgroups 2A and 2B (U=290; P=0.3) (Table 8, Fig 8).

Table 11: Evaluation of stereopsis of the individuals enrolled in the current study

Group (no of individuals)	Mean stereopsis (arc seconds)	Statistical analysis (Mann-Whitney 'U' test)
Group 1 (50)	76.80±34.37	Group 1 vs Group 2 U=490.5, P<0.001
Group 2 (50)	195.6±137.04	

Group 1= Individuals (n=50) with BCVA ≥ 6/18.

Group 2=Individuals (n=50) with BCVA < 6/18.

5.6 Evaluation of visual fields in both eyes of the individuals enrolled in the current study.

In Group 1, all the patients had normal visual fields. In Group 2, all the patients in subgroup 2A had normal visual fields and in subgroup 2B, three patients had peripheral constriction (Table 12). The proportion of individuals with normal visual fields in Group 1 was not significantly different from that in Group 2 (Table 12) (by Pearson Chi-square test { χ^2 (d.f=1)=3.093, P=0.079}. Similarly the proportion of individuals with normal visual fields in subgroup 2A was not significantly different from that in subgroup 2B by Chi-square test {{χ^2 [d.f=1]=1.0;P=0.3) (d.f=1)=3.191, P=0.074} (Table 12).

Table 12: Visual fields of the individuals enrolled in the current study.

Group (100)	Patients with field defects	Statistical analysis (Chi-square test)	Sub groups	Patients with field defects	Statistical analysis (Chi-square test)
Group1 (50)	0	Group 1 vs 2 values	1A (25)	0	Subgroups 1A vs 1B
		{ χ^2 (d.f=1)=3.093, p=0.079}	1B (25)	0	NIL
Group2 (50)	3		2A (25)	0	Subgroups 2A vs 2B
			2B (25)	3	{ χ^2 (d.f=1)=3.191, p=0.074}

5.7 Evaluation of fusional range of the individuals enrolled in the current study.

The mean fusional range was 14.78±2.45 degrees in Group 1 individuals and 15.82±3.53 degrees in Group 2 individuals (Table 13); this difference was borderline statistically significant (Mann-Whitney'U' test; U=967, P=0.048).

The mean fusional range was 15.04 ± 2.52 degrees in subgroup 1A, 14.52 ± 2.40 degrees in subgroup 1B, 15.96± 3.66 degrees in subgroup 2A and 15.68 ± 3.47 degrees in subgroup 2B. (Table 8). The difference in mean fusional range values between subgroups 1A and 1B individuals was not statistically significant (U=292, P=0.686). Similarly, the difference in mean fusuional range values between individuals in subgroups 2A and 2B was not statistically significant (U=288, P=0.63) (Table 8).

Table -13: Evaluation of mean fusional range of the individuals enrolled in the current study

Group (100)	Mean fusional range. (degrees)	Statistical analysis (Mann-Whitney 'U' test)
Group 1 (50)	14.78±2.45	Group 1 vs Group 2 values U=967, p=0.048
Group 2 (50)	15.82±3.53	

Group 1= Individuals (n=50) with BCVA ≥ 6/18.

Group 2=Individuals (n=50) with BCVA < 6/18.

6. ASSESSMENT OF ORTHOPTIC PARAMETERS

6.1 Evaluation of near point of convergence (NPC) of the individuals enrolled in the current study.

The mean NPC as measured by RAF ruler was 11.18±2.00 cms in Group 1 individuals and 9.82±2.33 cms in Group 2 individuals (Table 14); this difference was statistically significant (Mann-Whitney'U' test; U=899; P=0.010).

The mean NPC was 11.36 ± 2.15 cms in subgroup 1A, 11.00 ± 1.87 cms in subgroup 1 B, 9.32 ± 2.39 in subgroups 2A, 10.32 ± 2.21 in subgroups 2B (Table 8); The difference in mean NPC values between individuals in subgroups 1A and 1B was not statistically significant (U=234.5;P=0.116). Similarly, the difference between mean NPC values between individuals in subgroups 2A and 2B was not statistically significant (U=234.5, P=0.116), (Table 8).

Table 14. Evaluation of mean near point of convergence (NPC) of the individuals enrolled in the study

Group (no of individuals)	Mean NPC (cms)	Statistical analysis (Mann-Whitney 'U' test)
Group 1 (50)	11.18±2.00	Group 1 vs Group 2 values U=899, P=0.010
Group 2 (50)	9.82±2.33	

Group 1= Individuals (n=50) with BCVA ≥ 6/18.

Group 2=Individuals (n=50) with BCVA < 6/18.

6.2. Evaluation of near point of accommodation (NPA) in both eyes of the individuals enrolled in the current study

The mean NPA measured by RAF ruler was 11.36±2.15 D in Group 1 individuals and 9.52±2.53 D in Group 2 individuals. (Table 15); this difference was statistically significant (Mann-Whitney 'U' test; U=764.5, P<0.001).

The mean NPA measured by RAF ruler was 11.36 ± 2.15 D in subgroup 1A, 11 ± 1.87 Din subgroup 1B, 9.12 ± 2.58 D in subgroup 2A and 9.92 ± 2.46 D in subgroup 2B individuals (Table 8) The difference in mean NPA values between individuals in subgroups 1A and 1B was not statistically significant (U=296; P=0.257). Similarly, there was no statistically significant difference in mean NPA value between individuals in subgroups 2A and 2B (U=256.0, P=0.257) (Table 8).

Table- 15: Evaluation of mean near point of accomodation (NPA) in the eyes of the individuals enrolled in the study

Group (no.of individuals)	Mean NPA (cms)	Statistical analysis (Mann-Whitney 'U' test)
Group 1 (50)	11.18±2.00	Group 1 vs Group 2 values M=764.5, P<0.001
Group 2 (50)	9.52±2.53	

Group 1= Individuals (n=50) with BCVA ≥ 6/18.

Group 2=Individuals (n=50) with BCVA < 6/18.

7. ASSESSMENT OF FUNCTIONAL VISION

7.1 Mobility

Evaluation of mobility in unfamiliar places of the individuals enrolled in the study.

All the patients in Group 1 had independent mobility in unfamiliar places, but in Group 2, 14 patients in 2A and 12 patients in 2B had dependent mobility in unfamiliar places (Table 16). The proportion of individuals in Group 1 who had independent mobility in unfamiliar places was statistically significantly different from that in Group 2 (Pearson Chi-square test { x^2 [d.f=1]=35.1, P=<0.000} (Table 16). However, the proportion of individuals in subgroup 2A who had independent mobility in unfamiliar places was not significantly different, from that in individuals in Group 2B (Table 16) by Pearson chi-square test { (x^2 (d.f=1)=0.321, P=0.571}.

Table-16: Evaluation of the dependent mobility in unfamiliar places by the individuals enrolled in the current study

Group (no. of individuals)	No. of individuals with dependent mobility in unfamiliar places	Statistical analysis (Pearson Chi-square test)	Sub groups	No.of individuals with dependent mobility in unfamiliar places	Statistical analysis (Pearson Chi-square test)
Group 1 (50)	0	Group 1 vs 2 values	1A (25)	0	Subgroup 1A vs 1B NIL
		(x^2 [d.f=1]=35.1, P<0.001)	1B (25)	0	
Group2 (50)	26		2A (25)	14	Subgroup 2A vs 2B values { x^2 (d.f=10.321, P=0.571}
			2B (25)	12	

7.2 Evaluation of reading speed in the individuals enrolled in the study.

The mean reading speed was 86.22±20.33 words/min in Group 1 individuals and 29.06±20.34 words/min in Group 2 individuals (Table 17); this difference was statistically significant (Mann- Whitney U test ; (U=88, P<0.001).

The mean reading speed was 83.40 ±21.80 words/min in subgroup 1A individuals, 89.04± 18.10 words/min in subgroup 1B individuals (Table 17); this difference was not statistically significant (U=276.5; P=0.484). The mean reading speed was 21.12 ± 16.05 words /min in subgroup 2A individuals and 37.00 ± 21.35 words/min in subgroup 2B individuals (Table 17); this difference was statistically significant (U=169; P=0.005) (Table 17, Fig 9).

Table 17: Evaluation of the mean reading speed of individuals enrolled in the study

<table>
<tr><th>Group (no. of individuals)</th><th>Mean reading speed (words/min)</th><th>Statistical analysis (Mann-Whitney 'U' test)</th><th>Sub groups</th><th>Mean reading speed (words/min)</th><th>Statistical analysis (Mann-Whitney 'U' test)</th></tr>
<tr><td rowspan="2">Group 1 (50)</td><td rowspan="2">86.22±20.03</td><td>Group 1 vs 2 values</td><td>1A (25)</td><td>83.40 ± 21.80</td><td rowspan="2">Subgroups 1A vs 1Bvalues U=276.5, P=0.484</td></tr>
<tr><td rowspan="3">U=88 P<0.001</td><td>1B (25)</td><td>89.04 ± 18.10</td></tr>
<tr><td rowspan="2">Group 2 (50)</td><td rowspan="2">29.06±20.34</td><td>2A (25)</td><td>21.12 ± 16.05</td><td rowspan="2">Subgroups 2A vs 2B values U=169, P=0.005.</td></tr>
<tr><td>2B (25)</td><td>37.00 ± 21.35</td></tr>
</table>

Subgroup 1A=. Individuals (n=25) with BCVA ≥ 6/18 presenting for the first time

Subgroup 1B= Individuals (n=25) with BCVA ≥ 6/18 already using interventions.

Subgroup 2A=Individuals (n=25) with BCVA < 6/18 presenting for the first time

Subgroup 2B=Individuals (n=25) with BCVA< 6/18 already using interventions.

7.3. Evaluation of writing speed of the individuals enrolled in the study.

The mean writing speed was 36.38±7.02 words/ min in Group 1 individuals and 13.82±7.79 words/min in Group 2 individuals (Table 18); This difference was statistically significant (Mann-Whitney U test ;U=54.5, P<0.001).

In the subgroups, the mean writing speed was 35.00 ± 8.11 words/min in 1A, 37.76 ± 5.56 words/min in 1B, 9.92 ± 7.29 words/min in 2A and 17.72 ± 6.25 words/min in 2B (Table 18)The difference in mean writing speed between subgroups 1A and subgroup 1B individuals was not statistically significant (U=261.5;P=0.321) (Table 18). However, the difference in mean writing sped between subgroups 2A and subgroup 2B individually was statistically significant (U=123.5; P<0.001) (Table 18, Fig 10).

Table -18.Evaluation of mean writing speed of the individuals enrolled in the study

Group (no. of individuals)	Mean writing speed (words/min)	Statistical analysis (Mann-Whitney U test)	Subgroups	Mean writing speed (words/min)	Statistical analysis (Mann-Whitney U test)
Group 1 (50)	36.38±7.02	Group 1 vs 2 values U=54.5 P<0.001	1A (25)	35.00 ± 8.11	Subgroups 1A vs 1B values U=261.5, P=0.321
			1B (25)	37.76 ± 5.56	
Group 2 (50)	13.82±7.79		2A (25)	9.92 ± 7.29	Subgroups 2A vs 2B values U=123.5, P<0.001
			2B (25)	17.72 ± 6.25	

Subgroup 1A=. Individuals (n=25) with BCVA ≥ 6/18 presenting for the first time

Subgroup 1B= Individuals (n=25) with BCVA ≥ 6/18 already using interventions.

Subgroup 2A=Individuals (n=25) with BCVA < 6/18 presenting for the first time

Subgroup 2B=Individuals (n=25) with BCVA< 6/18 already using interventions.

7.4. Evaluation of reading errors of commission and omission

There were no errors of commission noted while reading in any subject in both the groups. There were no errors of omission noted in any subjects of group 1. In group 2, the mean number of words omitted while reading was 0.67 ± 0.34 words in patients in group 2A and 0.69 ± 0.32 words in patients in group 2B. This difference was found to be significant by Mann-Whitney U test (U=800, P=0.000).

Patients in group 2B were found to omit significantly lesser number of words (0.60±0.32 words) than those in group 2A (0.67 ±0.34) [U= 219.5, P = 0.034] (Table 19).

Table-19: Mean number of words omitted while reading.

Group	Mean	Statistical analysis	Subgroups	Mean	Statistical analysis
Group 1	NIL	Group 1 vs 2	1A	NIL	Group 1A vs 1B No significant difference
		U=800 P=0.000	1B	NIL	
Group 2	0.76±0.52		2A	0.67 ± 0.34	Group 2A vs 2B U=219.5, P=0.034
			2B	0.60 ± 0.32	

Subgroup 1A=. Individuals (n=25) with BCVA ≥ 6/18 presenting for the first time

Subgroup 1B= Individuals (n=25) with BCVA ≥ 6/18 already using interventions.

Subgroup 2A=Individuals (n=25) with BCVA < 6/18 presenting for the first time

Subgroup 2B=Individuals (n=25) with BCVA< 6/18 already using interventions.

8. FOLLOW UP AFTER SIX MONTHS

8.1 CLINICAL VISUAL ASSESSMENT

8.1.1. Evaluation of improvement in best corrected distant visual acuity (BCDV) of both eyes of individuals enrolled in the study who presented for follow-up.

All the individuals of Group 1 and 2 were followed-up after six months and evaluated for improvement in BCDV. The difference in mean value of BCDV at initial and follow- up visit were compared by Wilcoxon signed ranks test.

The mean BCDV at initial visit was 0.026±0.09 (Group 1) and 0.614 ±0.13 (Group 2) and the mean BCDV at follow-up visit was 0.022±0.08 (Group 1) and 0.608±0.13 (Group 2).

The difference between BCDV values at initial and follow-up visits was not statistically significant for Group 1 (Z=-1.414, P=0.57) or for Group 2 (Z=-1.342, P=0.180) (Table 20). The differences in mean BCDV values between initial visit and follow – up visit in the 4 subgroups were also not statistically significant (Table 21).

Table-20: **Improvement in best corrected distant visual acuity in both eyes of individuals in groups 1and 2 in the study who presented for follow-up**

Groups (no. of individuals)	Mean BCDV (logMAR units) at initial visit	Mean BCDV (logMARunits) at follow-up visit	Statistical analysis. (Wilcoxon signed ranks test)
Group 1 (50)	0.026±0.09	0.022±0.08	Z=-1.414, P=0.57
Group 2 (50)	0.614±0.13	0.608±0.13	Z=-1.342, P=0.180.

Group 1= Individuals (n=50) with BCVA ≥ 6/18.

Group 2=Individuals (n=50) with BCVA < 6/18

Table -21: **Improvement in best corrected distant visual acuity in both eyes of individuals in subgroups in the study who presented for follow-up**

Sub groups	Mean BCDV (logMAR units) at initial visit.	Mean BCDV (logMAR units) at follow-up visit	Statistical analysis (Wilcoxon signed ranks test)
1A (25)	0.05±0.12	0.04±0.10	Z=-1.414, P=0.157
1B (25)	0.00±0.0	0.00±0.0	Z=0.000, P=1.000
2A (25)	0.65±0.15	0.65±0.14	Z=1.000, P=0.317
2B (25)	0.57±0.09	0.56±0.09	Z=-1.000, P=0.317

Subgroup 1A=. Individuals (n=25) with BCVA ≥ 6/18 presenting for the first time

Subgroup 1B= Individuals (n=25) with BCVA ≥ 6/18 already using interventions.

Subgroup 2A=Individuals (n=25) with BCVA < 6/18 presenting for the first time

Subgroup 2B=Individuals (n=25) with BCVA< 6/18 already using interventions.

8.1.2. Evaluation of improvement in best corrected near visual acuity in both eyes of the individuals enrolled in the study who presented for follow-up.

The mean BCNV in Group 1 individuals was 0.63M at both initial and follow-up visits (Table 22). In Group 2, the mean BCNV at initial visit was 1.22 ± 0.727 M and 1.24 ± 0.73 M at the follow-up visit (Table 22);this difference was not statistically significant (Wilcoxon signed ranks test, (Z=1.000, P=0.317) (Table-22).

Similarly, there was no statistically significant difference between mean BCNV values at initial visit and follow-up visit in subgroups 1A, 1B, 2A and 2B (Table 23).

Table-22. Improvement in best corrected near visual acuity (BCNV) in both eyes of individuals in the four subgroups who presented for follow-up

Groups (100)	Mean BCNV (logMAR units) at initial visit.	Mean BCNV (logMAR units) at follow-up visit	Statistical analysis (Wilcoxon signed ranks test)
Group 1 (50)	0.63±0.0	0.63±0.0	Z=0.000, P=1.000
Group 2 (50)	1.22±0.727	1.24±0.73	Z=-1.000, P=0.317

Group 1= Individuals (n=50) with BCVA ≥ 6/18.

Group 2=Individuals (n=50) with BCVA < 6/18.

Table 23: **Improvement in best corrected near visual acuity (BCNV) in both eyes of individuals in the four sub groups who presented for follow-up**

Subgroups	Mean BCNV (logMAR units) at initial visit.	Mean BCNV (logMAR units) at follow-up visit	Statistical analysis. (Wilcoxon signed ranks test)
1A (25)	0.63±0.0	0.63±0.0	Z=0.000, P=1.000
1B (25)	0.63±0.0	0.63±0.0	Z=0.000, P=1.000
2A (25)	1.33±0.93	1.33±0.93	Z=0.000, P=1.000
2B (25)	1.11±0.43	1.16±0.46	Z=0.000, P=1.000

Subgroup 1A=. Individuals (n=25) with BCVA ≥ 6/18 presenting for the first time

Subgroup 1B= Individuals (n=25) with BCVA ≥ 6/18 already using interventions.

Subgroup 2A=Individuals (n=25) with BCVA < 6/18 presenting for the first time

Subgroup 2B=Individuals (n=25) with BCVA< 6/18 already using interventions.

8.2 FUNCTIONAL VISUAL SKILLS ASSESSMENT

8.2.1. Evaluation of improvement in reading speed of the individuals enrolled.

The mean reading speed in Group 1 was 86.22 ± 20.33 words/min at initial visit and 96.14±21.27 words/min at the follow-up visit (Table 24); this difference was statistically significant (Wilcoxon signed ranks test, Z=5.910, P<0.001) (Table 24). In Group 2, the mean reading speed was 29.06±20.34 at the initial visit and 33.84±20.44 at the follow-up visit; this difference also was statistically significant (Wilcoxon ranked signs test, Z=-5.349; P<0.001) (Table 24).

Similarly, statistically significant differences between mean reading speed at the initial visit and the follow-up visit were noted in individuals in all the subgroups (1A, 1B, 2A, 2B) who presented for follow-up (Table 25).

Table 24: **Improvement in reading speed in the individuals in study Groups 1 and 2 who presented for follow-up**

Groups (no. of individuals)	Mean reading speed (words/min) at initial visit.	Mean reading speed (words/min) at follow-up	Statistical analysis. (Wilcoxon ranked signs tests)
Group 1 (50)	86.22±20.03	96.14±21.27	Z=-5.910, P<0.001
Group 2 (50)	29.06±20.34	33.84±20.44	Z=-5.349, P<0.001

Group 1= Individuals (n=50) with BCVA ≥ 6/18.

Group 2=Individuals (n=50) with BCVA < 6/18.

Table 25:Improvement in reading speed in individuals in the four study groups who presented for follow-up

Subgroups	Mean reading speed (words/min) at initial visit	Mean reading speed (words/min) at follow-up	Statistical analysis (Wilcoxon ranked signs test)
1A (25)	83.40±21.80	93.48±23.61	Z=-4.297, P<0.001
1B (25)	89.04±18.10	98.8±18.7	Z=-4.111, P<0.001
2A (25)	21.12±16.05	25.04±15.7	Z=-3.405, P<0.001
2B (25)	37.00±21.35	42.68±20.97	Z=-4.207, P<0.001

Subgroup 1A=. Individuals (n=25) with BCVA ≥ 6/18 presenting for the first time

Subgroup 1B= Individuals (n=25) with BCVA ≥ 6/18 already using interventions.

Subgroup 2A=Individuals (n=25) with BCVA < 6/18 presenting for the first time

Subgroup 2B=Individuals (n=25) with BCVA< 6/18 already using interventions.

8.2.2. Evaluation of improvement in writing speed in individuals enrolled.

The mean writing speed in Group 1 was 36.38±7.02 words/ min at the initial visit and 42.10±8.90 words/ min at the follow-up visit (Table 26); this difference was statistically significant (Wilcoxon ranked signs test, Z=-5.726, P=<0.001). The mean writing speed was 13.82±7.79 at the initial visit and16.02±8.04 at the follow-up visit, in Group 2; this difference was also statistically significant (Wilcoxon ranked signs test, Z=-5.281, P<0.001).

Similarly, statistically significant differences between the mean writing speed at the initial visit and the mean writing sped at the follow-up visit were noted in all the subgroups (1A, 1B, 2A, 2B) of individuals who presented for 6 months follow-up (Table 27).

Table-26:**Improvement in writing speed in individuals in study Groups 1and 2 who presented for follow-up**

Mean writing speed (words/min) at initial visit	Mean writing speed (words/min) at follow-up visit	Statistical significance (Wilcoxon ranked signs test)
36.38±7.02	42.10±8.90	Z=-5.726, P<0.001
13.82±7.79	16.02±8.24	Z=-5.281, P<0.001

Group 1= Individuals (n=50) with BCVA ≥ 6/18.

Group 2=Individuals (n=50) with BCVA < 6/18.

Table-27: **Improvement in writing speed in individuals in the four study subgroups who presented for follow-up**

Subgroups (no.of individuals)	Mean writing speed (words/min)at initial visit	Mean writing speed (words/min)at follow-up visit	Statistical significance (Wilcoxon ranked signs test)
1A (25)	35.00±8.11	40.00±9.72	Z=-4.129, P<0.001
1B (25)	37.76±5.56	44.2±7.63	Z=-4.022, P<0.001
2A (25)	9.92±7.29	30.0±11.9	Z=-3.705, P<0.001
2B (25)	17.72±6.25	20.12±6.71	Z=-3.735, P<0.001

Subgroup 1A=. Individuals (n=25) with BCVA ≥ 6/18 presenting for the first time

Subgroup 1B= Individuals (n=25) with BCVA ≥ 6/18 already using interventions.

Subgroup 2A=Individuals (n=25) with BCVA < 6/18 presenting for the first time

Subgroup 2B=Individuals (n=25) with BCVA< 6/18 already using interventions.

AGE APPROPRIATE FUNCTIONAL SKILLS

Reading speed and writing speed.

None of the patients in Group 1 and Group 2 had age appropriate reading or writing speed.

CORRELATION OF CLINICAL WITH FUNCTIONAL PARAMETERS:

Reading speed

In Group 1, there was a significant positive correlation of reading speed with age (0.847), writing speed (0.885), follow-up reading speed (0.943), follow-up writing speed (0.847) and negative correlation with logMAR BCDV (-0.463) and follow-up logMAR BCDV (-0.312).

In Group 2, there was a significant positive correlation of reading speed with age (0.653), stereopsis (0.329), writing speed (0.762), follow-up reading speed (0.926), follow-up writing speed (0.804) and negative correlation with logMAR BCDV (-0.338), confusion angle of colour vision (-0.297), omission of words during reading (-0.652), follow-up BCDV (-0.386) (Table 28).

Table 28:Correlation (Spearmann's rho)of reading speed with clinical and functional skill parameters

PARAMETERS	POSITIVE CORRELATION		NEGATIVE CORRELATION	
	GR 1	GR 2	GR 1	GR 2
READING SPEED	Age (0.847)	Age (0.653)	BCDV (-0.463)	BCDV (-0.338)
	–	Stereopsis (0.329)	–	Confusion angle (-0.297)
	Writing speed (0.885)	Writing speed (0.762)	–	Omission of words (-0.652)
	FU reading speed (0.943)	FU reading speed (0.926)	–	–
	FU writing speed (0.847)	FU writing speed (0.804)	FU BCDV (-0.312)	FU BCDV (-0.386)

Writing speed

In Group 1, there was a significant positive correlation of writing speed with age (0.827), reading speed (0.855), follow-up reading speed (0.877), follow-up writing speed (0.801) and negative correlation with logMAR BCDV (-0.463), stereopsis (-0.323) and follow-up logMAR BCDV (-0.435).

In Group 2, there was a significant positive correlation with age (0.778), colour vision (0.282), stereopsis (0.297), NPC (0.282), NPA (0.339), reading speed (0.762), follow-up reading speed (0.835), follow-up writing speed (0.965) and negative correlation with logMAR UCDV (-0.290), logMAR BCDV (-0.316), omission of words during reading (-0.643), follow-up logMAR BCDV (-0.362) (Table 29).

Table 29: Correlation (Spearmann's rho) of writing speed with clinical and functional parameters

PARAMETERS	POSITIVE CORRELATION		NEGATIVE CORRELATION	
	GR 1	GR 2	GR 1	GR 2
WRITING SPEED	Age (0.827)	Age (0.778)	–	UCDV (-0.290)
	–	Stereopsis (0.297)	Stereopsis (-0.323)	–
	–	Colour vision (0.282)	BCDV (-0.463)	BCDV (-0.316)
	–	NPC (0.282)	–	–
	–	NPA (0.339)	–	Omission of words (-0.643)
	Reading speed (0.855)	Reading speed (0.762)	FU BCDV (-0.435)	FU BCDV (-0.362)
	FU reading speed (0.877)	FU reading speed (0.835)	–	–
	FU writing speed (0.801)	FU writing speed (0.965)		

STATISTICAL ANALYSIS

There was statistically significant difference in age, gender, refractive errors, BCDV, BCNV, colour vision, contrast sensitivity, stereopsis, fusional range, NPC, NPA and functional visual skills like mobility, reading speed and writing speed between Group 1 and 2. There was statistically significant improvement in functional visual skills like reading and writing speed, at follow-up after 6 months, in Group 1 & Group 2.

There was statistically significant difference in BCDV between the subgroups IA & IB in Group 1 and 2A & 2B in Group 2.

There was statistically significant difference in mean age distribution, reading speed, writing speed and reading errors of omission between the 2A and 2B in Group 2.

Fig 1: MEAN AGE OF THE INDIVIDUALS ENROLLED IN THE STUDY

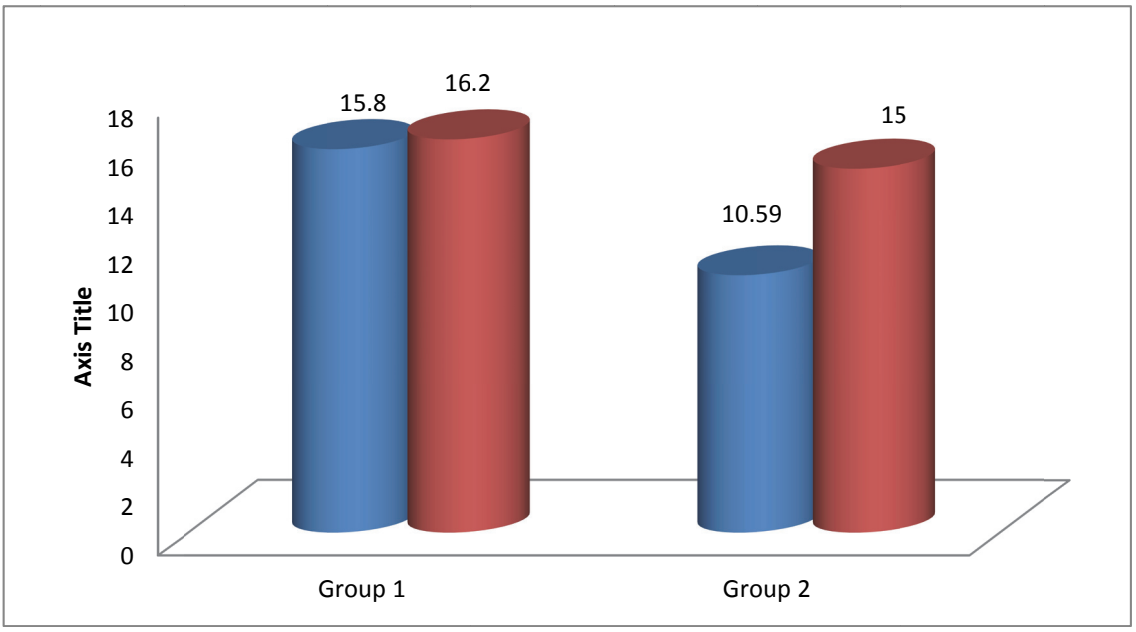


Fig 2: GENDER OF THE INDIVIDUALS ENROLLED IN THE STUDY.

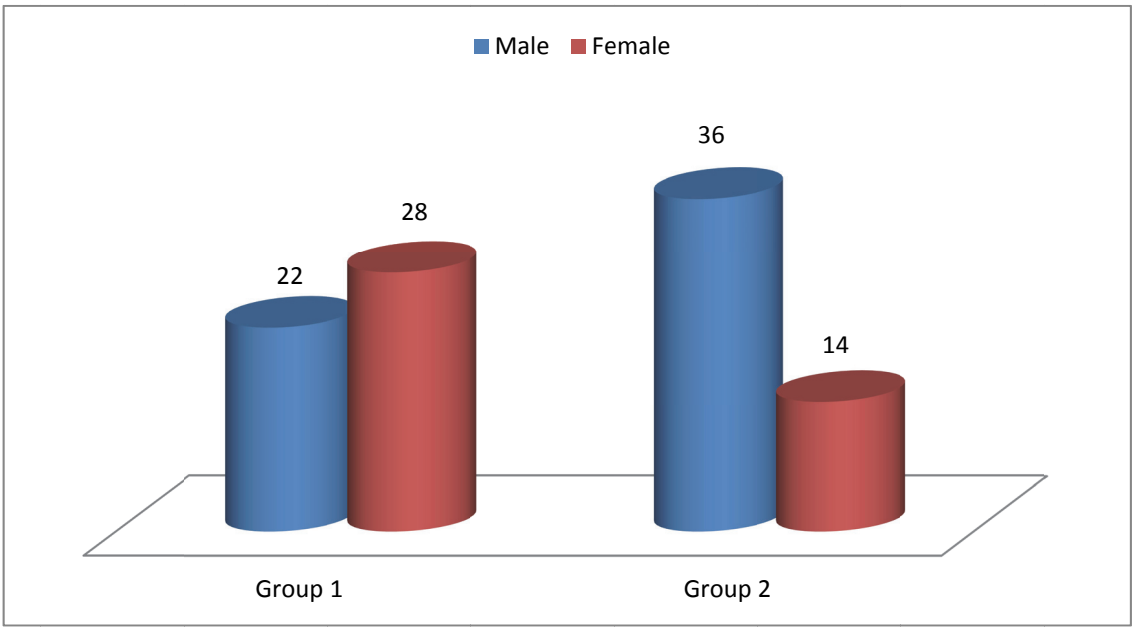


Fig 3: REFRACTIVE ERRORS OF BOTH EYES OF THE INDIVIDUALS IN THE STUDY

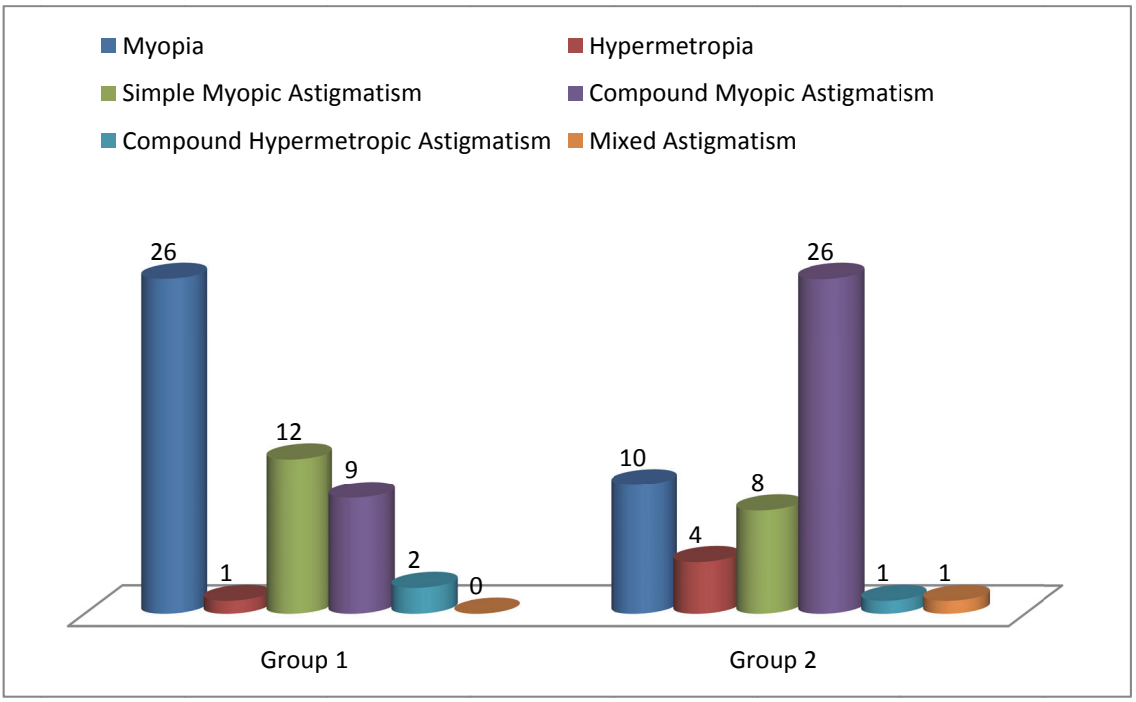


Fig 4: INTERVENTIONS PRESCRIBED TO THE INDIVIDUALS IN THE STUDY.

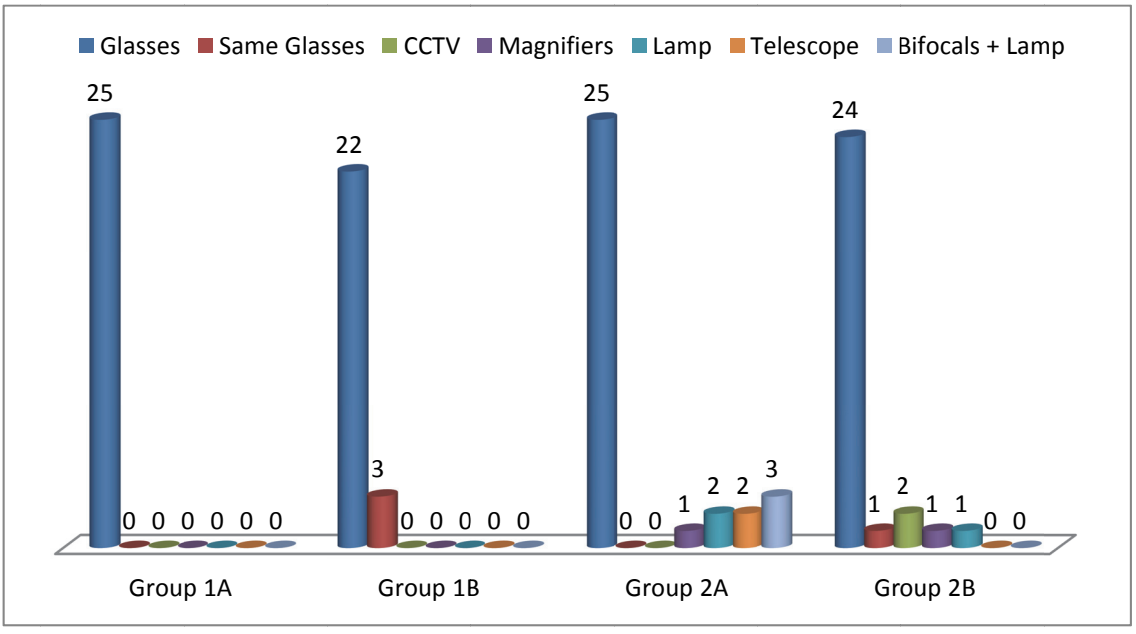


Fig 5: BEST CORRECTED DISTANT VISUAL ACUITY IN BOTH EYES

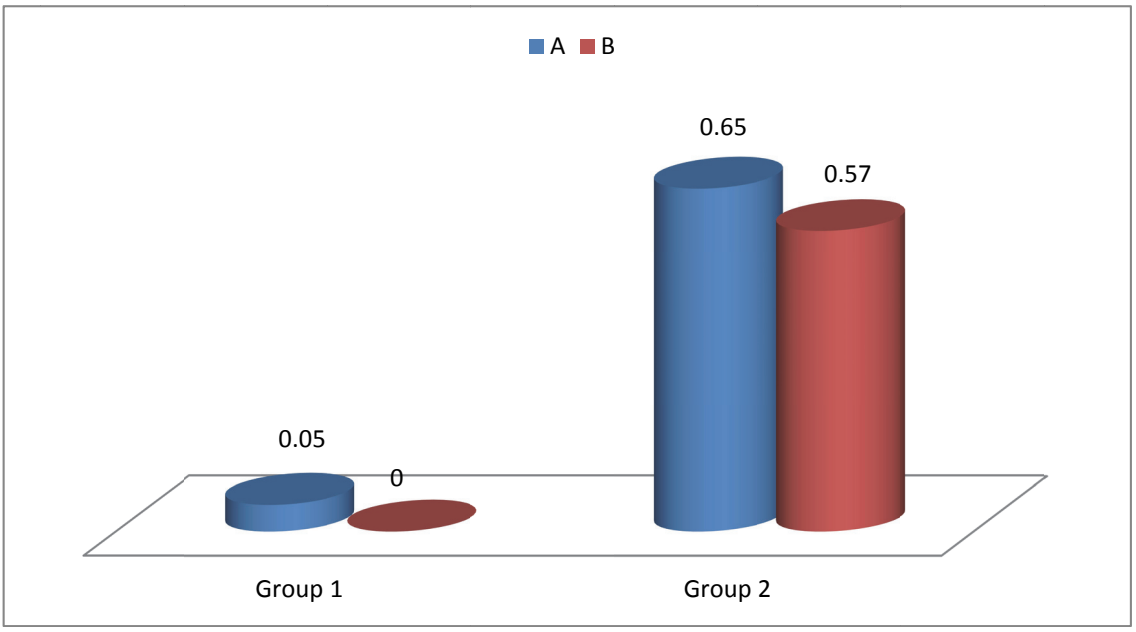


Fig 6: TYPES OF COLOUR VISION DEFECT IN BOTH EYES.

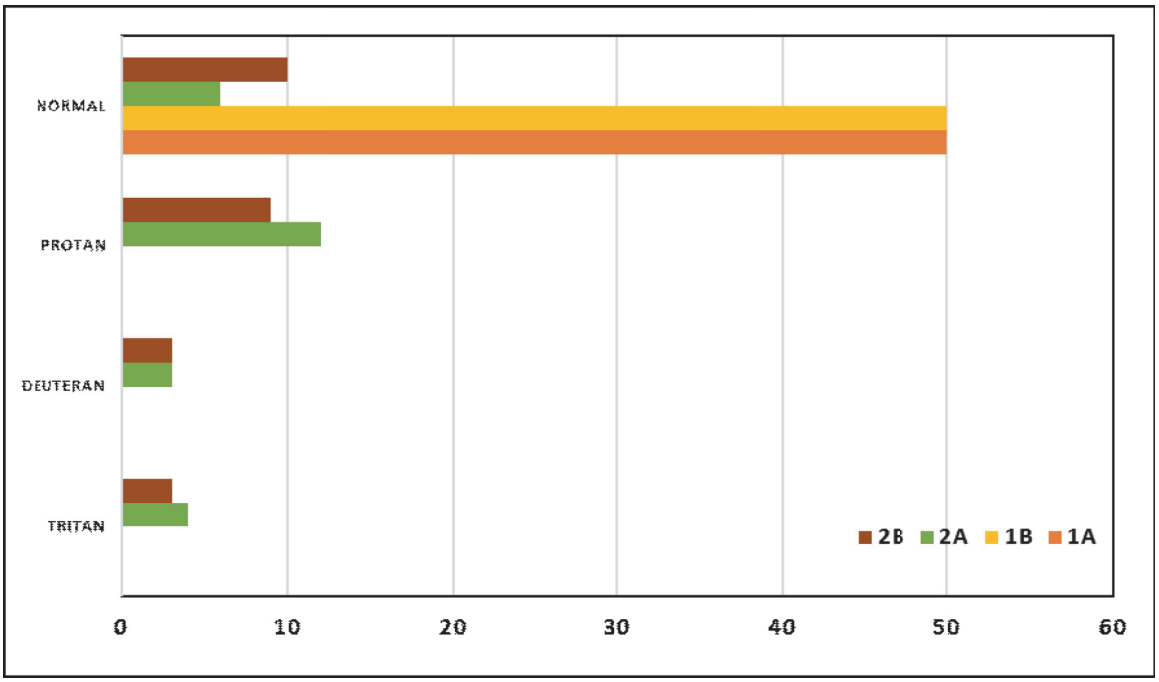


Fig 7:MEAN CONTRAST SENSITIVITY IN BOTH EYES OF THE INDIVIDUALS

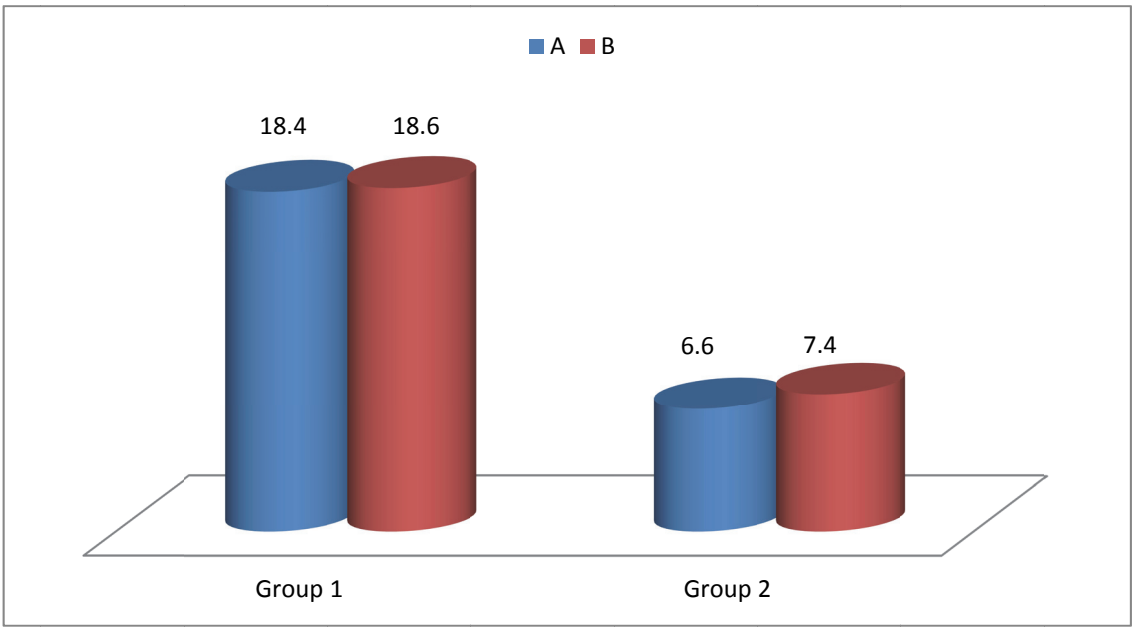


Fig 8:MEAN STEREOPSIS IN BOTH EYES OF THE INDIVIDUALS.

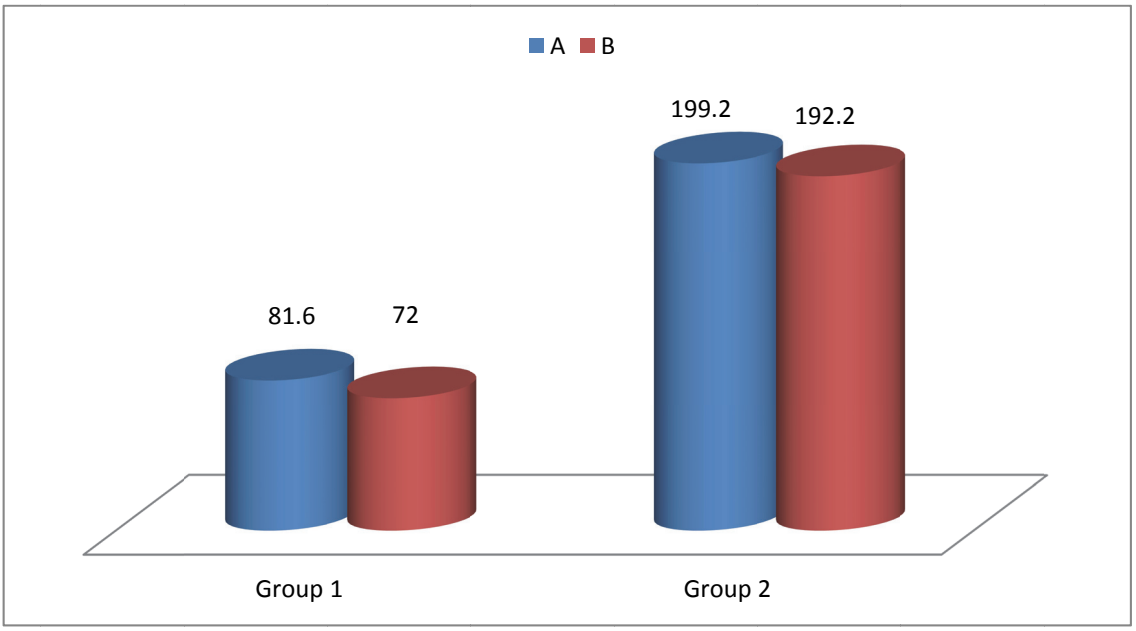


Fig 9: MEAN READING SPEED OF THE INDIVIDUALS IN THE STUDY

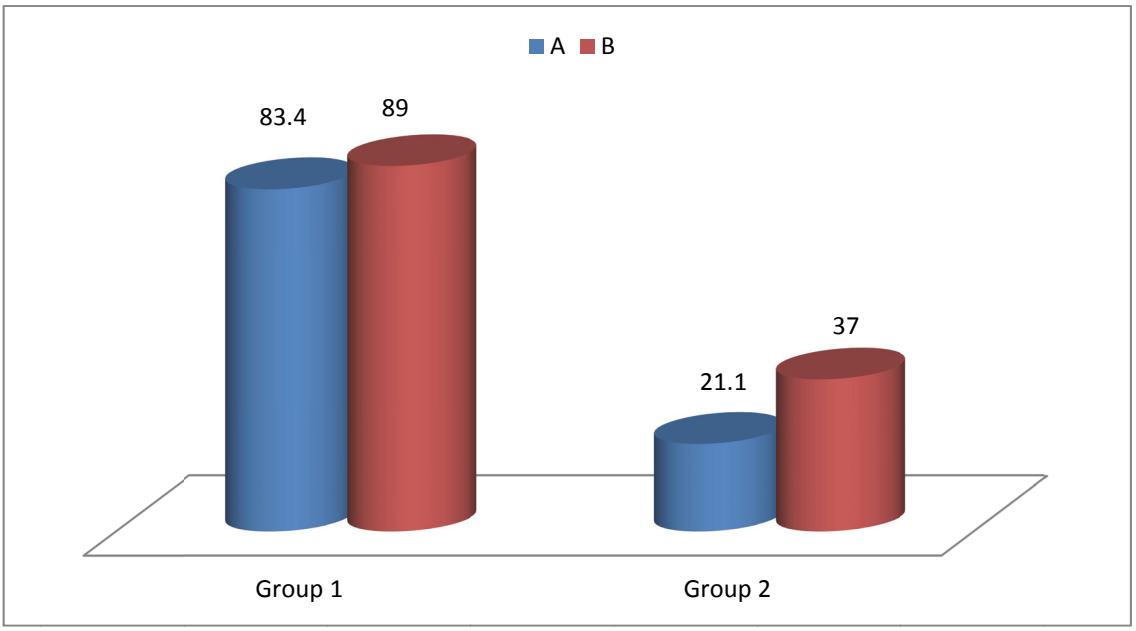
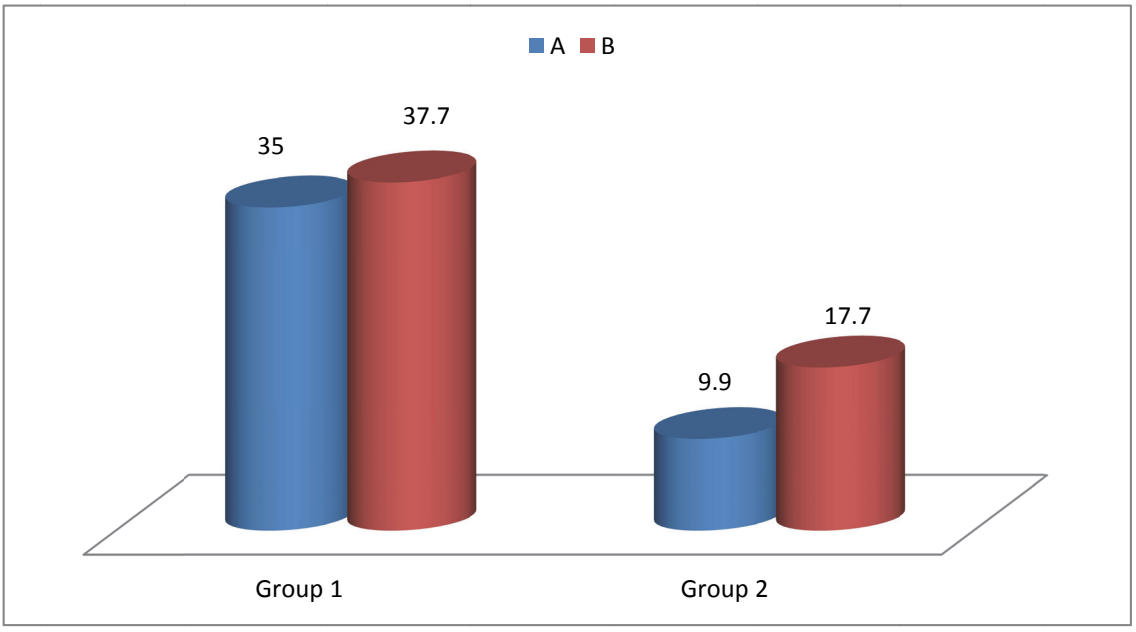


Fig 10: MEAN WRITING SPEED OF THE INDIVIDUALS IN THE STUDY



Discussion

DISCUSSION

The World Health Organisation (WHO, 2011) estimates, that there are more than 285 million people worldwide who are visually impaired, of whom nearly 39 million people are blind and 246 million suffer from low vision[1]. Visual impairment is a worldwide concern and it is very likely that it will gain more importance as the present standard of medical therapy is on the rise and the average life expectancy of an individual is lengthened.

According to the 'Disease control and prevention of visual impairment' program, VISION 2020[66], the main cause of visual impairment is uncorrected refractive error, which affects persons of all ages. Such errors may result in reduced education and employment opportunities, lower productivity and impaired quality of life.Currently, there are 153 million people with visual impairment due to uncorrected refractive errors with presenting visual acuity <6/18. Globally, uncorrected refractive errors are the main cause of visual impairment in children aged 5-15 years.

The control of blindness due to uncorrected refractive errors, especially in children, has been accorded high priority within VISION 2020[66]- The Right to Sight programme of the WHO. An estimated 19 million children are visually impaired and, out of these, 12 million children are visually impaired due to refractive errors[1]. (WHO/ Visual impairment and Blindness 2011).

A person with low vision has a best corrected visual acuity in the better eye of less than 6/18 to light perception or a central visual field of less than 20

degrees, but who uses or has the potential to use vision for the planning and execution of a task[13].

'Functional vision ' describes how a person functions in vision- related activities. Functional vision represents vision mediated performance of tasks required for daily living. It is impacted by cognition, emotion, language, physical abilities and educational oppurtunities[6].

A high quality of life, the right of every individual, is mandatory for the development of a confident, socially and economically-independent existence. This outcome is dependent on the ability to perform various activities at home, school and community. The quality of life of a person depends on the quality of his vision[7] (Taylor et al 2008). The presence of any impairment in visual skills may lead to problems in daily activities. Even simple activities, simple day-to-day communication skills or interaction with other people, which were previously taken for granted, might be disturbed.

Low vision evaluation refines many of the measurements made during the general eye examination, and also addresses functional visual skills through evaluation of the individual's basic visual functions and also through the application of these visual capacities in specific functional tasks. This functional evaluation is attained by applying standard tests that relates to functional activities such as reading and writing.

Evaluation of functional vision differs from the basic eye examination in that it primarily assesses how well a person uses vision to perform routine tasks

in different places, and with different materials, throughout the day. Differences in performance noted in the clinical and educational or rehabilitation setting provides information that is valuable in determining appropriate interventions.

The major goal of this evaluation is to obtain detailed information about an individual's current visual performance on functional tasks performed in the home, school, workplace and the society, so as to determine the most effective compensatory method to improve performance of tasks and, therein to increase his or her independent participation in various tasks.

The current study attempted to document the comparison of visual functions in children and young adults with refractive errors and also addresses the outcome of ophthalmological interventions after six months.

In the present study, the overall study population comprised 58% males and 42% females with refractive errors. In Group 1, (50 patients with refractive errors) 44% were males and 56% were females (mean age of 15.96 years). In group 2, 50 patients with refractive errors, 72% were males and 28% were females (mean age was 12.78 years).

The prevalence of refractive errors in Group 1 individuals was myopia in 26 (52%), hypermetropia in 1 (2%), simple myopic astigmatism in 12 (24%), compound myopic astigmatism in 9 (18%) and compound hypermetropic astigmatism in 2 (4%). In Group 2, myopia was present in 10 (20%), hypermetropia in 4 (8%), myopic astigmatism in 8 (16%), compound myopic

astigmatism in 26 (52%), compound hypermetropic astigmatism in 1 (2%) and mixed astigmatism in 1 (2%).

Sethi [52]et al (2000) found that myopia to be the most common refractive error among 417 school children aged 12-17 years. In the current study, while myopia was the most common refractive error in group 1while it was compound myopic astigmatism in the second group. This is further affirmed by Karki [28]et al (2006). In their study on prevalence of amblyopia in ametropes, 970 ametropic eye patients including children and young adults with best corrected visual acuity below 6/9, Myopic astigmatism (55.36%) followed by hypermetropic astigmatism and then hypermetropia and mixed astigmatism were the most refractive errors encountered. In our study also, compound myopic astigmatism was the commonest cause of low vision caused by refractive errors in group 2. This underlines the importance of identifying and managing astigmatism effectively and in early manner to present or treat amblyopia caused.

Interestingly, 57.14% of amblyopic patients in the study done by Karki[28] et al. were male, similar to the preponderance of male patients in group 2 noted in our study.Whether this reflects the gender predilection or health seeking behaviour of parents depending on the gender of the child has to be studied separately.

Colour vision was found to be affected in high axial myopia by Karkhane[29] et al. with tritan defect being the most common anomaly noticed. In our study, protan defect (42%) was the most commonly encountered colour vision abnormality among those with low vision due to ametropic

amblyopia.Our study used a computerised version of a similar test used in the said study. The difference in the colour vision could be because patients with various refractive errors have been grouped together in group 2.How far this anomaly in the colour vision perception will affect their activities of daily living is to be studied.

Acuity at a lower contrast results in a better indicator of visual performance than acuity at 100% contrast levels. Patients with low vision due to refractive errors had lower contrast acuity compared to this better vision. The low contrast acuity values could be a result of high refractive errors or spectacle associated defocus.Liou[30] et al have reported loss of contrast at high spatial frequencies in spectacle corrected high myopes. Some patients in their study gained contrast acuity with contact lenses.

Leat and Woodhouse[43] (1993) conducted a study on 30 adults and proved that the contrast sensitivity was a poor predictor of reading speeding at higher spatial frequencies than at the lower spatial frequencies, while in the present study there was no statistically significant correlation between contrast sensitiviy and reading speed.

Leat and Woodhouse [43] (1993) concluded that visual reading with low vision depends on visual requirements in terms of acuity (or magnification), contrast sensitivity and visual field. The present study also reports that there was statistically significant correlation between LOGMAR visual acuity and reading speed (-0.463 in Group 1 and -0.338 in Group 2).

Martin-Boglind[32] et al (1991), found that an error as little as 1D can significantly influence the visual fields. Performance of visual field testing without spectacles resulted in reduced peripheral visual field as well as reduction in contrast sensitivity. Another study by Ohno-Matsui[33] et al. (2011) found that significant visual field defects was significantly higher in myopic eyes. They conducted visual field examinations by Goldman kinetic perimetry for 492 eyes of 308 patients with high myopia (myopic refractive error >8D or axial length >26.5 mm). Significant visual field defects developed in 13.2% of highly myopic eye. In the current study, visual fields were examined by Bjerrum's screen, 97% of the patients with refractive errors had normal visual field except 3 patients in Group 2 had peripheral constriction of visual field.

Li S and Zou H[34] (2014) conducted a study on stereoscopic visual acuity in types of ametropic amblyopia in children which proved that children with astigmatism had the worst stereoacuity in case of mild and moderate amblyopia. In present study, the mean value of stereopsis in Group 1 was 76.80 arc secs and 195.6 arc secs in Group 2. This difference was statistically significant. It could be because 52% of patients in low vision group had compound myopic astigmatism with ametropic amblyopia.

Walraven and Jansen[35] (1993) recorded stereopsis in 730 children aged 4-18 years by TNO tests for early detection of amblyopia and a stereoacuity of less than or equal to 120 secs arc was considered as a good predictor of normal vision. In the present study, patients in Group 1 with mean stereopsis of 77.5 had

normal vision than the patients in Group 2 with mean stereopsis of about 195.5 who had ametropic amblyopia /low vision.

Singman and Matta[47] (2013) conducted a study of association between accomodative amplitudes (AA) and amblyopia. The Grand Seiko auto refractor (GSAR) was used to measure accomodative amplitudes in children with amblyopia and the result was confirmed by using the minus lens method, the near point of convergence by using Prince Rule, and retinoscopy. The accomodative amplitude was reduced in fifty-two children at 1/3 of a meter wearing their glasses correction during examination.But in the present study, the near point of accomodation was better in patients in low vision groups (Group 2) with mean value of about 9.52 cms, which was statistically significantly different from normal vision group with NPA of about 11.18 cms (Group 1).

Ruth E. Manny, Karen D.Fern[48] (2011) conducted a study on changes in fusional vergence, phoria and near point of convergence in myopic children in 114 individuals, aged 7-13 years and followed up annually for 10 years. During follow-up, measurements like refractive error for distance and near, prism bar fusional vergence range, near point of convergence were measured. After 10 years, the distance and near base out was decreased from 20 pd and 30 pd to 5.6 pd and 9.4 pd. This study concluded that for myopic children, the near point of convergence ranges decrease for both distance and near vision viewing as near phoria becomes more exophoric. In the current study, the mean near point of convergence was 11.18 cms in group 1 and 9.82 cms in group 2 because most of the patients in the study group are myopic cases.

A relationship between writing skills and visual-motor control was assessed in 42 students with low vision and 26 normal -sighted students by Atasavum Uysal[46] et al (2012). Significant differences were found between the groups in writing speed, legibility, and visual motor control. Visual motor control was correlated with both writing speed and legibility. Students with low vision had poorer handwriting performance, with lower legibility and slower writing speed. Writing performance time was related to visual motor control in students with low vision. In the current study, the mean writing speed was 36.3 words/ min in group 1, 13.8 words/min in group 2 and16.02 words /min in group 2 at follow-up visit. All the patients in group 2 had poorer writing speed and compared with patients in normal group.

The effectiveness of ophthalmological interventions in patients with refractive errors are monitored by visual acuity alone. The visual functions include not only the visual acuity but also the other parameters like colour vision, contrast sensitivity, stereopsis, fields, near point of convergence and accomodation. The functional skills like mobility, reading and writing skills are dependent not only on visual acuity, but aso on age, orthoptic parameters, contrast sensitivity and stereopsis.

In this study there were significant differences between clinical, orthoptic and functional vision parameters between low vision and normal vision groups. There were significant differences in functional visual skills within subgroups in low vision groups, but none of the patients in both groups had age appropriate functional skills, despite of improvement in visual acuity and functional skills at

follow-up. The comparison within subgroups proved that functional skills were better in patients, those who were already using interventions (Group 1B & 2B) than from the patients presenting for the first time (Group 1A &2A). The present study reports that regular follow-up with evaluation and correction of refractive error by glasses or contact lenses is necessary in children and young adults.

This study emphasizes the need for complete refractive correction of these patients after ensuring full cycloplegia, provision of appropriate optical and non-optical aids and enhancement of residual vision with correlation to what the individual requires for daily activities.

Summary

SUMMARY

The study on 'Visual functions in children and young adults with refractive errors' was conducted at the Institute of Ophthalmology, Joseph Eye Hospital, Tiruchirapalli from August 2014 to October 2014, in patients aged 5-30 years, who attended the out-patient clinic of the Paediatric Ophthalmolgy Department of the institution.

Visual functions were evaluated and the data compiled included ocular examination, refraction after cycloplegia, near vision, colour vision (Farnsworth D-15 test), contrast sensitivity (Lea low contrast 10 M test), visual fields (Bjerrum's screen), stereopsis (TNO card) test, orthoptic parameters of near point of accomodation, near point of convergence and functional visual skills like mobility, reading and writing speed assessment were done and prescribed correction. All were reviewed after six months.

The mean age of the patient was 15.96± 6.45 years in Group 1 aoupnd 12.78± 6.67years in Group 2. This difference was statistically significant (p=0.006, MannWhitney test). In Group 1, there were 22 (44%) males and 28 (56%) f emaleswhile in Group 2, there were 36 (72%) males and 14 (28%) females. There was a significantly higher proportion of male patients in Group 2 compared to Group 1 (P=0.005).

In Group 1, the prevalence of refractive errors were myopia in 26 (52%), hypermetropia in 1 (2%), myopic astigmatism in 12 (24%), compound myopic astigmatism in 9 (18%) and compound hypermetropic astigmatism in 2 (4%) and

in Group 2, myopia occurred in 10 (20%), hypermetropia in 4 (8%), myopic astigmatism in 8 (16%), compound myopic asigmatism in 26 (52%), compound hypermetropic astigmatism in 1 (2%) and mixed astigmatism 1 (2%). These differences were statistically significant between these Group 1 and 2 by Chi-square test (p=0.002).

In Group 1 and 2, distance vision correction was prescribed to all the patients except 3 patients in Group (2B), who were advised to continue the same glass. In addition, patients in Group 2 were advised to use non-optical aids for near work. There was a statistically significant difference in the proportion of interventions prescribed among subgroups of Group 1 ($p<0.001$) and not between the subgroups of Group 2.

Evaluating the clinical parameters, the BCDV (logMAR) of both eyes in Group 1 was 0.03 ± 0.09 and in Group 2 was 0.61± 0.13.As expected patients in group 1 had better BCDV compared to those in group 2 ($p<0.000$). In both the groups, review patients had better acuity than new patients (Group 1 (p=0.039) and Group 2 (p=0.020)).

The BCNV in Group 1 was 0.63±0.0 M and 1.22 ± 0.73M in Group 2.Patients in group 1 had better BCNV compared to those in group 2 (Mann-Whitney U test, p=0.000).

The mean confusion angle of the colour vision of both eyes in Group 1 was 69.04 ± 7.30 and in Group 2 was 21.13± 60.16. There was a significant

difference in mean confusion angle between Group 1 and 2 (Mann- Whitney U test, p=0.000), but there was no significant difference within the subgroups.

The colour vision in Group 1 was normal in all patients. In Group 2, 16 patients had normal colour vision, 21 had protan defect, six had deuteran defect and seven had tritan defect. This difference was statistically significant between Group 1 and 2 (Mann- Whitney U test, $p<0.001$) and there was no significant differences between mean values in subgroups in 2A and 2B.

The mean number of letters read in the contrast sensitivity chart at 3 meters was 18.50 ± 4.50 letters in Group 1 and 7.00 ± 5.43 letters in Group 2. This difference was statistically significant between group 1and 2 by Mann-Whitney U test (p=0.000),) but there was no significant differences between the mean values in subgroups 1A and 1B, and also no significant difference between mean values in subgroups 2A and 2B.

The mean stereopsis was 76.80 ± 42.00 arc secs in Group 1 and 195.6 ± 137.04 arc secs in Group 2. There was a statistically significant difference between Group 1 and 2 ($p<0.001$, Mann-Whitney U test), but there was no significant differences among subgroups between mean values in subgroups 1A and 1B or between mean values in subgroups 2Aand 2B.

The visual fields were normal in Group 1 patients and in Group 2, all the patients had normal visual fields except for 3 patients who had peripheral constriction of visual field. There was no statistically significant difference

between Group 1 and 2 by Chi-square test (p=0.079) and no difference among subgroups also.

The mean NPC in Group 1 was 11.18 ± 2.00 cms and 9.82 ±2.33 cms in Group 2. There was a statistically significant difference between Group 1 and 2 (p=0.010, Mann Whitney U test), but there was no statistically significant difference a between the mean NPC values in subgroups 1A and 1B and between the mean values in subgroups 2A and 2B.

The mean NPA was 11.18 ± 2.00 cms in Group 1 and 9.52 ± 2.53 cms in Group 2. This difference was statistically significant between Group 1 and 2 (p=0.000, Mann-Whitney U test), but there was no significant difference between mean NPA values in subgroups 1A and 1B and between the mean values in subgroups 2A and 2B.

All the patients in Group 1 had independent mobility in unfamiliar places, but in Group 2, 26 patients had dependent mobility in unfamiliar places. This difference was statistically significant ($p<0.001$). There was no significant difference between subgroup 2A and 2B in proportion of individuals exhibiting dependent mobility.

The mean reading speed was 86.22 ± 20.03 words/min in Group 1 and 29.06 ±20.34 words /min in Group 2, which was statistically significant ($p<0.001$, Mann-Whitney U test) and also had significant differences between subgroups of 2A and 2B in Group 2 (p=0.000), but not between subgroups 1A and 1B in Group 1.

The mean writing speed in Group 1 was 36.38 ± 7.02 words/min and 13.82 ± 7.79 words/min in Group 2 which was statistically significant ($p<0.001$, Mann-Whitney U test) and also had significant differences between subgroups 2A and 2B in Group 2 ($p=0.000$) and not between subgroups in Group 1.

The mean BCDV in Group 1 was 0.026 ± 0.09 at initial visit, 0.022 ± 0.08 at follow-up visit and the mean BCDV in Group 2 was 0.614 ± 0.13 at initial visit, 0.608 ± 0.13 at follow-up visit. There was no statistically significant difference between two visits in Group 1 ($p=0.57$) and in Group 2 ($p=0.183$, Wilcoxon signed ranks test) and no significant difference among subgroups.

The mean BCNV in Group 1 was 0.63 ± 0.0 M at both visits, and the mean BCNV in Group 2 was 1.22 ± 0.72 M at initial visit, 1.24 ± 0.73 M at follow-up visit. This difference was not statistically significant ($p=1.000$, Wilcoxon signed ranks test) between two visits in Group 1 and 2 and there was no statistically significant difference between subgroups 1A and1B and no significant difference between subgroups of 2A and 2B.

The mean reading speed in Group 1 was 86.22 ± 20.33 words/min at initial visit, 96.14 ± 21.27 words/min at follow-up visit and in Group 2, it was29.06 ± 20.34 words/min at initial visit and 33.84 ± 20.44 words/min at follow-up visit. Differences between Groups 1and 2 in mean reading speed values, and difference between subgroup 1A and 1B, difference in mean values of subgroups 2A and 2B were all statistically significant ($p<0.001$, Wilcoxon signed ranks test).

The mean writing speed in Group 1 was 36.38 ±7.02 words/min at the initial visit, and 42.10 ± 8.90 words/ min at the 6 th month follow-up visit and in Group 2, it was 13.82 ± 7.79 words/min at the initial visit, 16.02 ± 8.24 words/min at follow-up visit. Differences between mean values in Group 1 and 2, and differences in mean values in subgroups 1A and 1B and between mean values in subgroups 2A and 2B, were all statistically significant. There was statistically significant (p=0.000) difference in both visits and also had significant differences among subgroups of Group 1 and 2 (p=0.000, Wilcoxon signed ranks test).

There was a statistically significant difference in age, gender, refractive errors, BCDV, BCNV, visual fields, colour vision, contrast sensitivity, stereopsis, fusional range, NPC, NPA and functional visual skills like mobility, reading speed and writing speed between the Group 1 and 2. There was a statistically significant improvement in functional visual skills like reading and writing speed, at follow-up after 6 months, in Group 1 & Group 2.

None of the patients had age appropriate reading speed and writing speed at initial and follow-up visit even though there was improvement in functional skills at follow-up visit.

There was statistically significant difference in BCDV between the subgroups IA & IB in Group 1 and 2A & 2B in Group 2

There was statistically significant difference in mean age distribution, reading speed, writing speed and reading errors of omission between the 2A and 2B in Group 2.

Visual acuity is not the only criteria that determines the quality of life, but also the functional visual skills like reading, writing and mobility etc. are necessary to perform routine tasks in different places.

In the current study, patients with better visual acuity in Group 1 had satisfactory visual functions such as colour vision, contrast sensitivity, stereopsis, visual fields and also visual skills such as mobility, reading and writing speed etc. However, in low vision groups (2A and 2B), all the patients had poor visual functions even after refractive correction. This study emphasizes the need for refractive correction at regular intervals and also expert training of the patients in using their abilities for educational purposes.

Conclusion

CONCLUSION

Refractive errors, with or without associated amblyopia, can lead to reduced visual functions like contrast sensitivity, stereopsis, colour vision, visual fields and reduced functional skills such as reading, writing, mobility. These important determinants of quality of life, especially in children and young adults, which can lead to poor performance in education, vocation and other daily activities.

This study highlights the significance of visual functions and functional vision and regular follow-up, in patients with refractive errors especially in low vision patients. Mere improvement in visual acuity does not mean attainment of quality visual ability. In the present study, it is highlighted that although patients had an improvent in clinical visual parameters, the functional skills like reading and writing were not age appropriate. Inspite of improved clinical and functional vision with interventions, at short term follow-up, the visual skills required, were not age appropriate, both at initial and at also follow-up visit. Hence, the improvement in visual functions as well as functional vision parameters should be monitored as a criteria to determine the quality of vision in those with refractive errors especially in the paediatric age group.

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Informed Consent Form

INFORMED CONSENT FORM

Subject identification number for this trial _____

Title of the Project: _____

Name of the Principal Investigator _____ Tel. No. _____

I have received the information sheet on the above study and have read and / or understood the written information.

I have been given the chance to discuss the study and ask questions.

I consent to take part in the study and I am aware that my participation is voluntary. I understand that I may withdraw at any time without this affecting my future care.

I understand that the information collected about me from my participation in this research and sections of any of my medical notes may be looked at by responsible persons (ethics committee members / regulatory authorities). I give access to these individuals to have access to my records.

I understand I will receive a copy of the patient information sheet and the informed consent

form.

_____ _____

Signature / Thumb Impression of subject Date of signature

_____

Printed name of the subject in capitals

_____ _____

Signature / Thumb Impression of legally accepted representative Date of signature

<<The legally acceptable representatives signature should be added if the subject is a minor or is unable to sign for themselves. The relationship between the subject and the legally acceptable representative should be stated. The impartial witness signature should be added if the subject / legally acceptable representative is unable to read or write and consent should be obtained in his presence.>>

_____
Printed name of legally acceptable representative in capitals

_____
Relationship of legally accepted representative to subject in capitals

_____ _____
Signature of the person conducting the informed consent discussion | Date of signature

_____ _____
Printed name of the person conducting the informed consent discussion in capitals

_____ _____
Signature of impartial witness | Date of signature

_____
Printed name of the impartial witness in capitals

Proforma

JEH/R/LV-02/0

JOSEPH EYE HOSPITAL

LOW VISION DEPARTMENT

LV NO :

CASE HISTORY

Birth & Development History

H/o consanguinity	: No / Yes 1/2/3
Para	: 1/2/3/4/5
Prenatal period	
Maternal infections	:
Maternal immunization status	: Full / Partial
Abortion	: Spontaneous / Threatended
Perinatal period	
Labour	: Prolonged / Normal
Type of Birth	: Full Term / Pre mature / Post Dated
	: Normal / LSCS / Instrumental Birth
Birth Cry	: Normal / Delayed
Complications	:
Postnatal Period	
Diseases / infections	: Jaundice / Seizures / Fever / None / Others
Developmental Milestones	: Normal / Delayed
	: Language / Motor / Vision / Intellect
Associated problems	: VI / HI / MR / CP / MI / OH / LD / Others
General	: Diabetes / Hypertension / Cardiac / Asthma / None
Comments	:

FAMILY HISTORY

Family history of visual problems	: No / Yes
Economic status	: Low / Middle / High
Comments	:

MEDICAL HISTORY :

Previous Consultation : **Medication :**

Comments :

EDUCATIONAL HISTORY / STATUS

Type of School : Regular / IED / Blind / Spl School / CBR

Level of education : Pri / Sec / Hr.sec / College / ITI / Vocational

Literacy Media : Print / Braille / Large print / Regular / Audio cassettes

Lighting (Class room) : Dim / Moderate / Bright / Natural Light

Seating (Class room) : Front row / Middle row / Last row / Near blackboard / Near window

Comments :

VOCATIONAL HISTORY / STATUS

Occupation : Labourers / Self Employed / Business / Professionals / HW / Unemplyed.

Lighting :

Comments :

COMPLAINTS

Identified at : **Duration :**

Age of onset : Congenital / Acquired

Progression : Stable / Progressive / Not Known

Visual tasks :

Life Skills :

Color Vision :

Night Vision :

Mobility :

Comments :

JOSEPH EYE HOSPITAL

LOW VISION DEPARTMENT

CLINICAL EXAMINATION

LV NO :

OCULAR EXAMINATION :

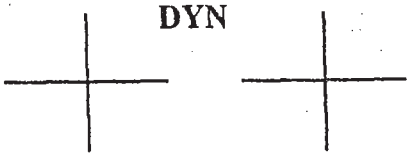
	RE	LE
Anterior segment	:	
Pupil	:	
Posterior Segment	:	

DIAGNOSIS :

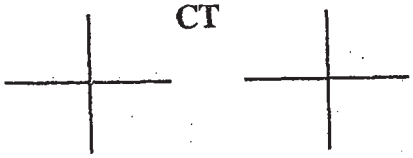
Preferred Eye	:
Fixation	:
Present Power Glasses	:
AR Value	:

Retinoscopy :

DYN



CT



Sub :

Sub :

Distant visual acuity **Test used**

Testing	RE	LE	BE
Without correction			
With pre / dyn correction			
With new correction			
With pin hole			

Telescope : Not using / Needed / Not Needed / No Improvement / Using

Tried : Kind / Power_____ VA : RE_____ LE_____

Near visual acuity **Test used**

Testing	RE	LE	BE
Without correction			
With pre / dyn correction			
With new correction			

ORTHOPTIC EVALUATION :

MAGNIFICATION

	Kind & Power
Not Using / Using	
Not tried / tried	
Nil Improvement / Improvement	

Combination : Micro. glas. + Bifocals + Hand Mag. + Stand Mag.

Types **Power** **Visual Acuity**

Test	Test used	RE	LE	Comments
Color vision				
Contrast Sensitivity				
Field				
Amsler's Gird Test				

JOSEPH EYE HOSPITAL

LOW VISION DEPARTMENT

FUNCTIONAL EXAMINATION

LV No :

Visual skills	Visual areas	Done / Not done (✓/×)	Comments
1. Awareness and attention to big objects	a) Attention		
	b) Reach		
2. Eye movement control (Tracking)	a) Maintain gaze		
	b) Tracking		
3. Eye movement control (Scanning)	a) Shift gaze		
	b) Change fixation		
4. Discriminate object	a) Find object		
	b) Follow path		
	c) Avoid object		
	d) Identify object		
5. Differentiate details for identifying action and object	a) Differentiation		
	b) Identification		
6. Differentiate details in pictures	a) Identify action		
	b) Complex picture		
7. Identification and perception of pattern, number and word	a) Abstract figures		
	b) Matching numbers		
	c) Inner detail		
	d) Matching words		
8. Eye-hand coordination			

Reading test : Too young / Pre reading / Illiterate / Not possible
.....words / minute @ .....cm (text book)

Writing test : Too young / Pre writing / Illiterate / Not possible
.....words / minute @.....cm (text book)

Comprehension :

Lighting : Dim / Bright / Moderate / Natural Light / Artificial Light

COLOUR : Not done / Too Young / Not possible / Done

Matching / Grouping / Identifying / Naming Test used :

FIELD : **RE** **LE** Test used :

Normal / Partially Restricted / Severely Restricted

CONTRAST SENSITIVITY : Not done / Too Young / Not possible / Done

Test used : Good / Average / Poor

New correction prescribed **Seperate / Bifocals**

	Spherical	Cylinder	Axis	Spherical	Cylinder	Axis
Distant Vision						
Near Vision						

Optical devices prescribed :

Medication / Surgery / other follow ups :

RECOMMENDATIONS & INTERVENTIONS

Devices

Optical devices Type / Power	Improvement	Prescribed	Obtained	Comments	Tried
Distant Vision					
Near Vision					
Non Optical	**Method & Position**	**Prescribed**	**Obtained**	**Comments**	**Tried**
1 2 3					

Environmental Adaptations :-

Advice :

Referral :

Ophthalmologist

Training :

Review :

Rehabilitationist

Master Chart

KEY TO MASTER CHART

Gender distribution

1- Males
2- Females

Refractive errors

1-Myopia
2-Hypermetropia
3-Myopic astigmatism
4-Hypermetropic astigmatism.
5-Compound myopic astigmatism.
6-Compound hypermetropic astigmatism
7-Mixed astigmatism.

Interventions

1-Glasses.
2-Continue the same glass.
3-Orthoptic exercises.
4-CCTV.
5-Hand magnifier.
6-Lamp
7-Binocular telescope.
8-Bifocals +Lamps.

Colour vision

1- Normal
2-Protan defect
3-Deuteran defect
4-Tritan defect.

Fields

1- Normal
2-Restricted

Mobility

0- Independent
1-Dependent

Aggregate visual skills

1- Appropriate to age development
2- Not appropriate to age development

NORMAL VISION - NEW

No	Name	age	sex	AS	PS	UCDV RE	UCDV LE	UCNV RE	UCNV LE	RE SPH	CYL RE	AXIS	LE SPH	CYL LE	AXIS	BCDV RE	BCDV LE	CV RE	CV LE	CS3M	CS 2M	CS 1M	FIELD	STEREOPS	BSV	FUSION	NPC	NPA	AXL RE	AXL LE	RE K1	AXIS	K2	AXIS	LE K1	AXIS	K2	AXIS	MF	MUF	RS W/M	AGE AP	WS W/M	AGE AP	COMP	COMMI	OMISS	D RE	D LE	TRT	EXERCI
1	Ganesh	10	1	normal	normal	0.4	0.4	0.63m	0.63m	-1	-0.5	160	-0.75	-0.5	20	0.00	0	61.9	61.9	15	25	25	normal	60	present	20	10	10	24.51	24.52	44.31	6	44.73	96	43.82	0	44.46	90	0	0	80	2	30	2	4/5	0	0	5	5	1	
2	Jeya sudha	12	2	normal	normal	0.2	0.2	0.63m	0.63m	0	-0.75	180	0	-0.75	180	0	0	72.5	72.5	25	25	25	normal	60	present	12	12	12	23.47	23.63	44.22	10	44.53	90	44.02	20	44.23	100	0	0	80	2	36	2	4/5	0	0	3	3	1	3
3	Arulappan	18	1	normal	normal	0.4	0.4	0.63m	0.63m	-1	0	0	-1	0	0	0	0	79.4	79.4	25	25	25	normal	60	present	16	10	10	24.2	24.22	43.82	162	43.44	92	43.42	173	43.68	83	0	0	120	2	46	2	4/5	0	0	1	1	1	
4	Gowri	28	2	normal	normal	0.5	0.5	0.63m	0.63m	0	-2.25	90	0	-2.5	90	0	0	75	67.5	25	25	25	normal	120	present	16	10	10	24.54	24.52	44.53	171	44.23	59	44.6	105	44.67	68	0	0	98	2	42	2	4/5	0	0	3	3	1	
5	Ajith	10	1	normal	normal	0.8	0.4	0.63m	0.63m	4	1	30	3.5	0.75	160	0.3	0.2	74.3	74.3	25	25	25	normal	120	present	12	16	16	24.25	24.21	44.5	39	44.22	151	44.52	42	44.2	136	0	0	50	2	30	2	4/5	0	0	6	6	1	3
6	Santhosh	19	1	normal	normal	0.8	0.8	0.63m	0.63m	-2	0	0	-2	0	0	0	0	72.5	74.5	15	25	25	normal	60	present	15	12	12	23.36	23.31	46.12	172	46.61	82	45.42	173	46.4	83	0	0	108	2	43	2	4/5	0	0	1	1	1	
7	Durgasri	6	2	normal	normal	0.7	0.7	0.63m	0.63m	0	-3	180	0	-3	180	0.4	0.4	61.9	61.9	20	25	25	normal	60	present	12	12	12	24.1	24.3	43.85	12	44.39	87	44.5	22	44.7	76	0	0	48	2	20	2	4/5	0	0	3	3	1	3
8	Sasikala	17	2	normal	normal	0.8	0.9	0.63m	0.63m	-2	0	0	-2	0	0	0	0	61.9	61.9	15	25	25	normal	60	present	20	10	10	23.56	23.63	45	160	45.61	70	44.94	123	45.12	33	0	0	92	2	36	2	4/5	0	0	1	1	1	
9	Kavipriya	16	2	normal	normal	0.8	0.8	0.63m	0.63m	-2.5	0	0	-2.5	0	0	0	0	74.3	74.3	10	25	25	normal	60	present	17	10	10	25.29	25.41	42	21	42.75	169	41.75	22	42.5	168	0	0	98	2	41	2	4/5	0	0	1	1	1	
10	Jeevika	9	2	normal	normal	0.5	0.5	0.63m	0.63m	2	0	0	2	0	0	0	0	72.5	72.5	21	25	25	normal	120	present	14	14	14	21.12	21.16	42.62	6	43.16	144	42.84	10	43.6	125	0	0	65	2	27	2	4/5	0	0	2	2	1	3
11	Helen Jancy	26	2	normal	normal	1	1	0.63m	0.63m	-1.5	-1.25	120	-2.75	0	0	0	0	61.9	61.9	15	25	25	normal	60	present	13	12	12	24.12	24.16	43.83	132	44.35	42	44.53	89	44.76	179	0	0	102	2	44	2	4/5	0	0	5	1	1	3
12	Riswana	18	2	normal	normal	0.3	0.3	0.63m	0.63m	-0.8	0	0	-0.75	0	0	0	0	72.5	74.5	15	25	25	normal	60	present	15	12	12	24.2	24.69	44.31	89	44.86	11	44.14	76	45.52	20	0	0	92	2	38	2	4/5	0	0	1	1	1	
13	Kalairasi	20	2	normal	normal	0.5	0.5	0.63m	0.63m	-1	0	0	-1	0	0	0	0	79.4	79.4	22	25	25	normal	60	present	15	10	10	23.51	23.8	44.23	14	43.82	72	43.62	11	44.34	69	0	0	88	2	36	2	4/5	0	0	1	1	1	
14	Jeyalakshmi	15	2	normal	normal	1	1	0.63m	0.63m	-3	-0.5	180	-4	-0.5	30	0	0	61.9	61.9	20	25	25	normal	60	present	10	12	12	23.85	23.85	44.35	180	45.06	90	44.58	12	45.18	102	0	0	82	2	34	2	4/5	0	0	3	3	1	3
15	Parvathi	30	2	normal	normal	0.5	0.5	0.63m	0.63m	0	-1.5	100	0	-1.5	80	0	0	72.5	72.5	15	25	25	normal	120	present	12	18	18	24.44	24.36	43.42	122	45.77	51	43.84	108	45.63	63	0	0	115	2	44	2	4/5	0	0	3	3	1	
16	Karthikeyan	6	1	normal	normal	0.6	0.6	0.63m	0.63m	1.5	3	100	0.5	3.5	80	0.3	0.2	75	57	5	15	25	normal	120	present	12	14	14	21.12	20.91	41.62	20	45.76	139	41.93	22	45.72	130	0	0	45	2	22	2	4/5	0	0	6	6	1	3
17	Kalanther Arif	14	1	normal	normal	0.4	0.4	0.63m	0.63m	-0.8	0	0	-0.75	0	0	0	0	79.4	79.4	15	25	25	normal	60	present	16	10	10	22.92	22.97	45.55	12	46.11	103	45.25	13	45.92	101	0	0	78	2	32	2	4/5	0	0	1	1	1	
18	Gokula kannan	7	1	normal	normal	1.3	1.3	0.63m	0.63m	-6	-1.5	180	-6	-1	180	0.3	0.3	57	61.9	10	25	25	normal	240	present	15	10	10	25.5	25.8	43.11	21	44.21	21	42.52	168	44.12	168	0	1	52	2	22	2	4/5	0	0	5	5	1	
19	Pravin Bharti	27	1	normal	normal	0.1	0.3	0.63m	0.63m	0	-0.75	70	0	-1	120	0	0	72.5	72.5	25	25	25	normal	60	present	16	11	11	23.4	23.1	45.73	131	44.92	41	45.49	22	44.96	112	0	0	90	2	40	2	4/5	0	0	3	3	1	
20	Magil Mary	6	2	normal	normal	1	1	0.63m	0.63m	-1.5	-4.5	180	0	-5	180	0	0	75	79.4	20	25	25	normal	120	present	16	9	9	23.3	22.2	41.54	19	46.33	104	41.54	159	45.62	69	0	1	50	2	21	2	4/5	0	0	3	3	1	
21	Kowsalya	16	2	normal	normal	0.5	0.4	0.63m	0.63m	0	-2.5	180	0	-3	170	0	0	72.5	73.4	20	25	25	normal	60	present	18	10	10	23.05	22.82	41.36	19	44.47	109	42.45	159	45.24	69	0	0	84	2	35	2	4/5	0	0	3	3	1	
22	Manikandan	23	1	normal	normal	0.6	0.4	0.63m	0.63m	-2	0	0	-2	0	0	0	0	61.9	74.5	15	25	25	normal	60	present	15	10	10	23.87	23.91	42.38	132	43.35	42	42.45	89	43.48	179	0	0	110	2	46	2	4/5	0	0	1	1	1	
23	Daniel Joshua	14	1	normal	normal	0.2	0.2	0.63m	0.63m	-1	0	0	-1	0	0	0	0	72.5	74.3	25	25	25	normal	60	present	15	10	10	22.9	22.8	43.3		43.6		43.4		43.8		0	0	82	2	36	2	4/5	0	0	1	1	1	
24	vinothini	18	2	normal	normal	0.5	0.5	0.63m	0.63m	0	-2	180	0	-2	180	0	0	75	75.4	22	25	25	normal	60	present	16	10	10	23.8	23.6	39.5	10	44.25	100	40.5	15	44.5	15	0	0	102	2	44	2	4/5	0	0	3	3	1	
25	Aswiniraj	9	1	normal	normal	1	1	0.63m	0.63m	-3	0	0	-3.5	0	0	0	0	57	57	20	25	25	normal	60	present	18	10	10	24.55	24.61	43.1	180	43.89	90	43.6	170	44.47	80	0	0	74	2	30	2	4/5	0	0	1	1	1	

FOLLOW UP AFTER 6 MONTHS

VN+PG RE	VN+PG LE	RE SPH	RE CYL	AXIS	LE SPH	LE CYL	AXIS	BCV RE	BCV LE	RS W/M	AGE AP	WS W/M	AGE AP	TRT
0	0.1	-1	-0.5	160	-1	-0.5	20	0	0	85	2	32	2	1
0.1	0.1	0	-1	180	0	-1	180	0	0	90	2	36	2	1
0	0	-1	0	0	-1	0	0	0	0	120	2	50	2	2
0	0	0	-2.25	90	0	-2.5	90	0	0	125	2	48	2	2
0.4	0.3	4	1	20	4	1	160	0.2	0.2	70	2	30	2	1
0	0	-2	0	0	-2	0	0	0	0	120	2	52	2	2
0.5	0.5	0	-3.5	180	0	-3.5	180	0.4	0.4	52	2	20	2	1
0	0	-2	0	0	-2	0	0	0	0	112	2	53	2	2
0	0	-2.5	0	0	-2.5	0	0	0	0	106	2	45	2	2
0.2	0.2	-2.5	0	0	-2.5	0	0	0	0	70	2	30	2	1
0	0	-1.5	-1.25	120	-2.75	0	0	0	0	115	2	49	2	2
0	0	-0.75	0	0	-0.75	0	0	0	0	110	2	51	2	2
0	0	-1	0	0	-1	0	0	0	0	104	2	42	2	2
0.1	0	-3.5	-0.5	180	-4	-0.5	30	0	0	90	2	36	2	1
0	0	-1.5	3.5	100	1.5	3.5	80	0.2	0.2	50	2	26	2	1
0.1	0.1	-1	0	0	-1	0	0	0	0	88	2	43	2	1
0.3	0.4	-6	-1.5	180	-6	-1.5	180	0.3	0.3	54	2	26	2	1
0	0	0	-0.75	70	0	-1	120	0	0	98	2	42	2	2
0.2	0.2	-1.5	-5	180	-1	-5	180	0	0	60	2	27	2	1
0	0	0	-2.5	180	0	-3	170	0	0	92	2	38	2	2
0	0	-2	0	0	-2	0	0	0	0	118	2	52	2	2
0	0	-1	0	0	-1	0	0	0	0	90	2	40	2	2
0	0	0	-2	180	0	-2	180	0	0	118	2	48	2	2
0.1	0	-3.5	0	0	-3.5	0	0	0	0	80	2	36	2	1

NORMAL VISION - REVIEW

No	Name	age	sex	AS	PS	UCDVR	UCDVL	UCNVR	UCNV L	VN+PG R	VN+PG L	PGP RE	RE CYL	AXIS	PGP RE	CYL LE	AXIS	RE SPH	CYL RE	AXIS	LE SPH	CYL LE	AXIS	BCDVR	BCDVL	CV RE	CV LE	CS 3 M	CS 2 M	CS 1M	FIELD	STEREOP	BSV	FUSION	NPC	NPA	AXL RE	AXL LE	RE K1	AXIS	K2	AXIS	LE K1	AXIS	K2	AXIS	MF	MUF	RS W/M	AGE AP	WS W/M	AGE AP	COMP	COMMI	OMISSI	D-RE	D-LE	TRT	EXERCISE
1	Kiruthika	22	2	Normal	normal	0.8	0.8	0.63m	0.63m	0.1	0.1	-1.25	0.00	0.00	-1.25	0.00	0.00	-1.50	0.00	0.00	-1.50	-0.50	100.00	0.0	0.0	61.9	61.9	15	25	25	normal	60	present	15	10	10	23.36	23.42	44.6	156	43.77	78	43.94	132	44	46	0	0	120	2	42	2	4/5	0	0	1	5	1	
2	Satheeswaran	16	1	Normal	normal	1.2	1.2	0.63m	0.63m	0.9	0.9	-3.25	0.00	0.00	-3.25	0.00	0.00	-4.25	0.00	0.00	-4.00	0.00	0.00	0.0	0.0	61.9	61.9	20	25	25	normal	120	present	17	9	9	24.51	24.13	44.9	172	45.67	81	44.82	8	45.3	98	0	0	106	2	36	2	4/5	0	0	1	1	1	
3	Prasana	16	1	Normal	normal	1	1	0.63m	0.63m	0.2	0.2	-2.00	0.00	0.00	-2.25	0.00	0.00	-2.25	0.00	0.00	-3.00	0.00	0.00	0.0	0.0	72.5	72.5	20	25	25	normal	60	present	10	12	12	23.85	23.85	44.4	80	45.06	90	44.58	12	45.18	102	0	0	110	2	40	2	4/5	0	0	1	1	1	3
4	wilson joseph	7	1	Normal	normal	0.9	0.9	0.63m	0.63m	0.7	0.1	0.00	-2.50	180.00	0.00	-2.00	180.00	0.00	-3.00	180.00	0.00	-3.00	180.00	0.0	0.0	74.3	72.5	15	25	25	normal	60	present	18	10	10	23.61	23.46	42.8	22	43.16	100	44.2	158	44.12	67	0	0	70	2	30	2	4/5	0	0	3	3	1	
5	Gopika sree	8	2	Normal	normal	1	1	0.63m	0.63m	0.1	0.1	-1.75	-0.50	180.00	-1.75	-0.25	180.00	-2.00	-0.50	180.00	-2.00	-0.50	180.00	0.0	0.0	61.9	61.9	15	25	25	normal	60	present	12	14	14	23.63	23.56	45	160	45.61	30	44.94	143	45.12	36	0	0	72	2	32	2	4/5	0	0	5	5	1	
6	Durga sree	6	2	Normal	normal	0.7	0.7	0.63m	0.63m	0.4	0.4	0.00	-3.00	180.00	0.00	-3.00	180.00	0.00	-3.00	180.00	0.00	-3.00	180.00	0.0	0.0	78.5	61.9	15	25	25	normal	60	present	15	10	10	23.52	23.76	41.4	20	44.37	107	42.44	158	45.25	72	0	0	64	2	30	2	4/5	0	0	3	3	1	
7	visalatchi	18	2	Normal	normal	1.2	1.2	0.63m	0.63m	0.1	0.1	-2.25	0.00	0.00	-2.50	0.00	0.00	-2.75	0.00	0.00	-3.00	0.00	0.00	0.0	0.0	72.5	72.5	20	25	25	normal	120	present	16	10	10	23.96	23.88	44.4	180	45.02	92	44.68	11	44.92	101	0	0	98	2	40	2	4/5	0	0	1	1	1	
8	Calebsteeve	15	1	Normal	normal	0.7	0.7	0.63m	0.63m	0	0	-1.25	-0.50	160.00	-1.00	-0.75	10.00	-1.00	-0.50	160.00	-0.75	-0.50	20.00	0.0	0.0	74.3	74.5	20	25	25	normal	60	present	16	10	10	23.04	22.92	43.4	18	43.61	110	44.02	161	43.82	70	0	0	72	2	43	2	4/5	0	0	5	5	1	
9	Emalda prince	20	2	Normal	normal	0.3	0.3	0.63m	0.63m	0.1	0.1	0.00	-0.75	100.00	0.50	-0.75	70.00	0.00	-1.25	180.00	0.00	-1.00	80.00	0.0	0.0	61.9	61.9	20	25	25	normal	60	present	17	10	10	23.67	24.21	44.3	171	44.26	85	44.12	170	44.2	82	0	0	98	2	42	2	4/5	0	0	3	3	1	
10	Dillis avila	7	2	Normal	normal	1.3	1.3	0.63m	0.63m	0.1	0.1	-5.00	0.00	0.00	-5.00	0.00	0.00	-5.50	0.00	0.00	-5.00	0.00	0.00	0.0	0.0	74.3	74.5	15	25	25	normal	120	present	12	16	16	25.43	25.49	45	6	45.98	96	45.18	0	46.17	90	0	0	60	2	32	2	4/5	0	0	1	1	1	3
11	Riyas parveen	19	2	Normal	normal	1.2	1.2	0.63m	0.63m	0.6	0.6	-3.00	0.00	0.00	-3.00	0.00	0.00	-4.00	0.00	0.00	-4.00	0.00	0.00	0.0	0.0	72.5	72.5	15	25	25	normal	60	present	15	10	10	24.21	24	47	10	47.61	108	46.73	106	47.72	84	0	0	110	2	45	2	4/5	0	0	1	1	1	
12	Anisha parveen	13	2	Normal	normal	0.8	0.7	0.63m	0.63m	0.1	0.1	-1.75	0.00	0.00	-1.25	0.00	0.00	-2.00	0.00	0.00	-1.50	0.00	0.00	0.0	0.0	79.9	79.9	20	25	25	normal	60	present	15	10	10	23.56	23.63	45	160	45.61	70	44.94	123	45.12	33	0	0	80	2	40	2	4/5	0	0	1	1	1	
13	Manikandan	23	1	Normal	normal	0.4	0.5	0.63m	0.63m	0.1	0.1	-1.75	0.00	0.00	-1.75	0.00	0.00	-1.00	-1.00	180.00	-0.50	-0.50	160.00	0.0	0.0	61.9	61.9	25	25	25	normal	60	present	17	10	10	23.32	23.71	42.4	165	44.08	44	42.32	172	43.42	36	0	0	94	2	44	2	4/5	0	0	5	5	1	
14	Deepika	17	2	Normal	normal	1.2	1	0.63m	0.63m	0	0.1	-3.50	0.00	0.00	-2.50	0.00	0.00	-3.50	0.00	0.00	-3.00	0.00	0.00	0.0	0.0	72.5	73.5	20	25	25	normal	60	present	11	12	12	24.6	24.46	43.3	24	43.98	94	44.21	172	43.53	87	0	0	88	2	40	2	4/5	0	0	1	1	1	3
15	Sabeetha	16	2	Normal	normal	0.9	0.7	0.63m	0.63m	0.7	0.2	-0.75	0.00	0.00	-0.50	0.00	0.00	-1.50	0.00	0.00	-1.00	0.00	0.00	0.0	0.0	74.3	57	20	25	25	normal	60	present	16	10	10	23.39	23.44	45.7	130	45.9	40	45.46	22	46.12	112	0	0	107	2	46	2	4/5	0	0	1	1	1	
16	Mohammed	18	1	Normal	normal	1.2	1.2	0.63m	0.63m	0.9	0.9	-2.75	0.00	0.00	-3.00	0.00	0.00	-5.50	-0.50	180.00	-5.00	-0.50	180.00	0.0	0.0	57.00	57.00	15	25	25	normal	120	present	17	10	10	25.27	25.3	45.3	8	47.18	96	45.32	176	47.27	94	0	0	90	2	38	2	4/5	0	0	5	5	1	
17	Hari prasad	10	1	Normal	normal	1	1	0.63m	0.63m	0.2	0.3	-3.00	0.00	0.00	-2.75	0.00	0.00	-3.25	0.00	0.00	-3.25	0.00	0.00	0.0	0.0	67.5	78.5	15	25	25	normal	60	present	13	12	12	24.32	24.16	43.1	14	43.95	104	44.61	174	44.53	84	0	0	60	2	28	2	4/5	0	0	1	1	1	3
18	ramavenkatesh	21	1	Normal	normal	0.8	0.8	0.63m	0.63m	0	0	-1.50	0.00	0.00	-1.75	0.00	0.00	-1.50	0.00	0.00	-1.75	0.00	0.00	0.0	0.0	72.5	72.5	25	25	25	normal	60	present	16	10	10	23.45	23.63	44.2	167	45.22	78	44.52	163	44.32	82	0	0	92	2	36	2	4/5	0	0	1	1	2	
19	Bhuvaneswari	30	2	Normal	normal	0.8	1	0.63m	0.63m	0.1	0.1	-4.00	0.00	0.00	-5.25	0.00	0.00	-4.00	-0.50	10.00	-5.25	-0.25	120.00	0.0	0.0	57.7	74.5	20	25	25	normal	60	present	12	16	16	25.32	25.43	44.3	7	44.08	97	46.02	178	46.27	76	0	0	120	2	45	2	4/5	0	0	5	5	1	3
20	Yaheswari	12	2	Normal	normal	0.6	0.8	0.63m	0.63m	0	0	-1.00	0.00	0.00	-1.50	0.00	0.00	-1.00	0.00	0.00	-1.50	0.00	0.00	0.0	0.0	61.9	61.9	20	25	25	normal	60	present	15	10	10	23.43	23.71	44.3	126	44.32	51	44.61	33	44.52	110	0	0	86	2	34	2	4/5	0	0	1	1	2	
21	vasanth	15	1	Normal	normal	1.2	1.2	0.63m	0.63m	0	0.2	-5.00	0.00	0.00	-4.25	0.00	0.00	-4.50	-0.50	180.00	-4.50	-0.50	180.00	0.0	0.0	57.7	57.7	15	25	25	normal	120	present	11	12	12	26.52	26.21	42.7	160	42.66	88	42.32	170	43.67	72	0	0	80	2	30	2	4/5	0	0	5	5	1	
22	Arun kumar	23	1	Normal	normal	0.8	0.8	0.63m	0.63m	0.1	0.1	-1.00	0.00	0.00	-1.25	0.00	0.00	-1.50	0.00	0.00	-1.50	0.00	0.00	0.0	0.0	79.4	79.4	25	25	25	normal	60	present	10	12	12	24.12	24.31	43.4	132	44.02	42	43.32	89	44.41	179	0	0	108	2	44	2	4/5	0	0	1	1	1	3
23	santhosh	22	1	Normal	normal	0.5	0.6	0.63m	0.63m	0	0	-1.75	0.00	0.00	-1.75	0.00	0.00	-1.75	0.00	0.00	-1.75	0.00	0.00	0.0	0.0	61.9	72.5	15	25	25	normal	60	present	15	10	10	23.92	24.01	44	144	44.2	72	43.6	158	44.02	64	0	0	93	2	40	2	4/5	0	0	1	1	2	
24	Rahmathnisha	14	2	Normal	normal	0.74	0.74	0.63m	0.63m	0.1	0.1	-1.50	0.00	0.00	-1.50	0.00	0.00	-1.75	0.00	0.00	-1.75	0.00	0.00	0.0	0.0	57	61.9	20	25	25	normal	60	present	16	10	10	23.58	23.64	44.8	160	44.07	70	44.84	122	44.26	32	0	0	76	2	35	2	4/5	0	0	1	1	1	
25	Iswarya	16	2	Normal	normal	0.6	0.6	0.63m	0.63m	0.1	0.1	-1.00	0.00	0.00	-1.50	0.00	0.00	-1.25	0.00	0.00	-1.50	-0.50	180.00	0.0	0.0	72.5	72.5	20	25	25	normal	60	present	16	10	10	22.65	22.78	46.5	172	47.16	82	46.29	173	47.41	83	0	0	72	2	32	2	4/5	0	0	1	1	1	

FOLLOW UP AFTER 6 MONTHS

VN+PG RE	VN+PG LE	RE SPH	CYL RE	AXIS	LE SPH	LE CYL	AXIS	BCV RE	BCV LE	RS W/M	AGE APP	WS W/M	AGE AP	TRT
0.1	0.1	-1.8	0	0	-1.8	-0.5	180	0	0	140	2	56	2	1
0	0.1	-4.3	0	0	-4.3	0	0	0	0	110	2	50	2	1
0	0	-2.3	0	0	-3	0	0	0	0	110	2	49	2	2
0.1	0.1	0	-3.25	180	0	-3.3	0	0	0	72	2	34	2	1
0.1	0.1	-2.5	-0.5	180	-2.5	-0.5	180	0	0	72	2	32	2	1
0.1	0.1	0	-3.5	180	0	-3.5	180	0	0	70	2	30	2	1
0	0	-2.8	0	0	-3	0	0	0	0	102	2	42	2	2
0	0	-1	-0.5	160	-0.8	-0.5	20	0	0	94	2	43	2	2
0	0	0	-1.25	180	0	-1	180	0	0	112	2	50	2	2
0	0.1	-5.5	0	0	-5.5	0	0	0	0	65	2	32	2	1
0	0	-4	0	0	-4	0	0	0	0	120	2	50	2	2
0	0	-2.3	0	0	-1.8	0	0	0	0	90	2	42	2	1
0	0	-1	-1	180	-0.5	-0.5	160	0	0	100	2	48	2	2
0	0	-3.5	0	0	-2.5	0	0	0	0	102	2	51	2	2
0	0	-1.5	0	0	-1	0	0	0	0	110	2	50	2	2
0	0	-5.5	-0.5	180	-5.5	-0.5	180	0	0	115	2	52	2	2
0.1	0.1	-3.5	0	0	-3.5	0	0	0	0	70	2	30	2	1
0	0	-1.5	0	0	-1.8	0	0	0	0	103	2	42	2	2
0	0	-4	-0.5	10	-5.3	0.25	120	0	0	120	2	50	2	2
0	0	-1	0	0	-1.5	0	0	0	0	90	2	40	2	2
0	0	-5	0	0	-5	0	0	0	0	97	2	48	2	1
0	0	-1.5	0	0	-1.5	0	0	0	0	115	2	52	2	2
0	0	-1.8	0	0	-1.8	0	0	0	0	110	2	48	2	2
0	0	-1.8	0	0	-1.8	0	0	0	0	95	2	44	2	2
0.1	0.1	-1.5	0	0	-1.5	0	0	0	0	86	2	40	2	2

Low Vision - New

S.NO	Name	Age	Sex	AS	PS	UCDV RE	UCDV LE	UCNV RE	UCNV LE	RE Sph	RE Cyl	RE axis	LE Sph	LE Cyl	LE axis	BCDV RE	BCDV LE	BCNV RE	BCNV LE	C VN RE	DEFECT	C VN LE	DEFECT	CS at 3m
1	Bharani	5	1	normal	normal	1.3	1.3	0.6	0.6	-10.00	-2.50	40	-10.00	-2.50	150	0.6	0.6	0.6	0.6	67.4	2	57.6	2	5
2	Gokul	7	1	normal	normal	0.9	0.9	0.6	0.6	-6.00	-1.50	180	-6.00	-1.50	180	0.5	0.5	0.6	0.6	-37.4	2	-18.3	3	10
3	Silambarasan	13	1	normal	normal	1.6	1.6	2	2	-10.00	0.00	0	-10.00	0.00	0	0.6	0.6	1.2	1.2	-49.5	3	40.5	2	15
4	Nitheshwaran	6	1	normal	normal	1.3	1.3	7.5	7.5	-11.00	0.00	0	-10.00	0.00	0	1	1	4	4	-42.3	2	60.6	2	0
4	Nitheswaran	6	1	normal	normal	1.3	1.3	7.5	7.5	-11.00	0.00	0	-10.00	0.00	0	1	1	4	4	-42.3	2	60.6	2	0
5	Mohamed	13	1	normal	normal	0.7	0.7	3.2	3.2	0.00	-2.00	180	0.00	-2.50	180	0.6	0.6	2.5	2.5	86.8	2	-85.8	4	0
6	Selvi	12	2	normal	normal	1	1	0.8	0.8	-1.00	0.00	0	-1.00	0.00	0	0.7	0.7	0.8	0.8	-25.9	1	32.2	1	5
7	Durga	10	2	normal	normal	1	1	1	1	-2.50	-3.50	180	-2.00	-4.00	180	0.7	0.7	0.8	0.8	75.5	1	57.7	2	10
8	Fathima	6	2	normal	normal	1	1	0.6	0.6	-4.50	-0.50	90	-4.50	-0.50	90	0.5	0.5	0.6	0.6	75.7	2	53.6	2	10
9	Janani	7	2	normal	normal	1.3	1.3	3	3	-12.00	-1.50	180	-12.00	-1.50	180	0.6	0.6	0.8	0.8	53	1	71.6	1	15
10	Kumaravel	7	1	normal	normal	1	1	0.6	0.6	-7.00	-2.00	30	-7.50	-0.50	180	0.7	0.7	0.6	0.6	-1.8	3	-6.9	3	15
11	Dharsan	5	1	normal	normal	1	1	0.6	0.6	-4.00	-1.50	20	-4.00	-1.50	180	0.7	0.7	0.6	0.6	85.9	1	67.3	2	10
12	Saronfritic	8	1	normal	normal	1	1	1.2	1.2	0.00	-4.00	20	0.00	-4.00	160	0.5	0.5	1.2	1.2	75.7	1	71.6	1	10
13	Divagar	10	1	normal	normal	1	1	3	3	0.00	-1.50	70	0.00	-1.50	90	0.8	0.8	2	2	-81.9	4	-88.4	4	5
14	Paul mathew	5	1	normal	normal	1.3	1.3	2	2	-11.00	0.00	0	-10.00	0.00	0	0.7	0.7	1.5	1.5	89.9	2	53	2	0
15	Kaviarasan	12	1	normal	normal	1.3	1.3	1.5	1.5	-11.00	0.00	0	-11.00	0.00	0	0.5	0.5	0.9	0.9	25.4	2	36.4	3	0
16	Umamahes	5	2	normal	normal	1.3	1.3	1.5	1.5	-6.50	0.00	0	-7.50	0.00	0	0.7	0.7	0.9	0.9	86.8	2	-85.8	4	10
17	Srihari	7	1	normal	normal	1	1	0.6	0.6	-4.50	-2.50	180	-5.00	-2.50	180	0.5	0.5	0.6	0.6	-86.8	4	56.5	2	5
18	Yuvaraj	9	1	normal	normal	1.3	1.3	4.2	4.2	-13.50	-1.50	10	-13.50	-1.50	170	0.6	0.6	1.3	1.3	-50.9	4	-69.1	4	10
19	Maniraja	13	1	normal	normal	1.1	1.1	1.2	1.2	-4.00	-1.50	180	-4.00	-1.50	100	0.6	0.6	0.9	0.9	31.8	2	-33.8	3	0
20	Chelladurai	16	1	normal	normal	1.3	1.3	2	2	12.50	0.00	0	12.50	0.00	0	0.6	0.6	1	1	-20.4	3	-7.4	3	10
21	Nickeshwaran	7	1	normal	normal	1	1	3.2	3.2	-7.00	-1.50	90	-8.00	-1.00	90	0.5	0.5	2.4	2.4	68.4	2	69.9	2	0
22	Anjali	14	2	normal	normal	1.6	1.6	1.5	1.5	-21.00	-2.00	180	-20.00	-1.50	150	0.9	0.9	1.5	1.5	46.9	2	74.3	1	5
23	suresh	30	1	normal	normal	1	1	0.9	0.9	0.00	-3.00	90	0.00	-3.50	70	0.6	0.6	0.8	0.8	61.9	1	64.7	2	5
24	Baskar	23	1	Normal	Normal	1.6	1.6	9.6	9.6	15.00	0.00	0	15.00	0.00	0	1.1	1.1	3.7	3.7	-77.4	4	27.8	2	0
25	Suresh	13	1	Normal	Normal	1.3	1.3	3	3	-14.00	0.00	0	-13.00	0.00	0	0.6	0.6	1.5	1.5	60.6	2	-42.3	3	10

S.NO	CS at 2m	CS at 1m	Field	Stereopsis	BSV	FUSION	NPC	NPA	RE AXL	LE AXL	RE K1	Axis	K2	Axis	LE K1	Axis	K2	Axis	MF	MUF	R.Sp word/min	distance	app. age	W. Sp word/min	distance in cm	app age	comp	commit	omission	D RE
1	15	25	Normal	60	present	15	8	8	27.45	27.00	41.92	160	44.01	40	42.85	180	44.41	90	0	1	3	25	2	2	20	2	4/5	0	2	1
2	20	25	Normal	60	present	19	8	8	26.41	26.38	43.00	180	43.21	90	43.45	180	43.22	90	0	1	3	25	2	2	20	2	4/5	0	1	5
3	25	25	Normal	240	present	15	15	8	27.63	28.04	42.99	90	43.16	180	43.16	151	43.95	61	0	1	40	26	2	10	20	2	4/5	0	#	1
4	5	10	Normal	120	present	18	12	12	27.82	27.80	43.42	90	44.00	180	43.15	90	43.12	180	0	1	3	25	2	2	10	2	4/5	0	1	1
4	5	10	Normal	120	present	18	12	12	27.82	27.80	43.42	90	44.00	180	43.15	90	43.12	180	0	1	3	25	2	2	10	2	4/5	0	1	1
5	10	15	Normal	60	present	16	12	12	23.35	23.43	42.61	5	44.58	95	42.67	176	44.88	86	0	1	50	15	2	28	15	2	4/5	0	0	3
6	15	25	Normal	120	present	10	12	12	22.41	22.39	45.67	156	45.98	66	45.67	17	46.04	107	0	0	50	20	2	8	20	2	4/5	0	#	1
7	20	25	Normal	120	present	15	12	12	23.33	23.35	42.61	90	44.51	180	42.62	90	44.68	180	0	0	6	30	2	2	30	2	4/5	0	#	5
8	20	25	Normal	60	present	15	6	6	24.92	24.14	43.38	13	44.00	103	44.12	178	44.82	88	0	1	4	30	2	2	30	2	4/5	0	#	5
9	25	25	Normal	120	present	20	6	6	26.05	25.90	44.41	174	46.55	84	44.47	180	46.47	90	0	1	4	28	2	2	28	2	4/5	0	#	5
10	25	25	Normal	240	present	19	8	8	26.66	26.44	40.56	17	42.29	107	41.87	6	42.67	96	0	0	15	28	2	9	28	2	4/5	0	#	5
11	20	25	Normal	240	present	18	10	10	23.88	23.70	45.36	20	47.60	110	45.55	2	47.74	92	0	0	7	28	2	2	28	2	4/5	0	#	5
12	20	25	Normal	480	present	15	10	10	23.55	23.67	40.25	8	44.50	98	40.00	10	44.00	80	0	0	30	25	2	15	25	2	4/5	0	#	3
13	15	25	Normal	120	present	17	10	8	22.52	22.33	44.33	110	44.52	70	43.21	180	44.95	90	0	0	10	10	2	6	10	2	4/5	0	#	3
14	5	25	Normal	120	present	19	6	6	25.66	25.76	43.95	180	44.57	90	44.83	180	44.11	90	0	1	8	15	2	5	15	2	4/5	0	#	1
15	10	25	Normal	240	present	15	10	10	26.04	26.13	42.43	110	42.34	70	41.31	105	43.00	70	0	1	52	22	2	15	15	2	4/5	0	#	1
16	20	25	Normal	60	present	20	8	6	25.41	24.47	46.53	21	45.55	170	45.77	111	45.32	80	0	1	10	25	2	5	20	2	4/5	0	#	1
17	15	25	Normal	120	present	11	8	8	26.00	26.04	39.00	11	41.52	111	39.52	10	41.71	85	0	0	15	30	2	10	30	2	4/5	0	#	5
18	25	25	Normal	480	present	20	6	6	27.31	27.33	46.33	21	44.38	170	46.15	111	45.19	76	0	0	26	18	2	10	15	2	4/5	0	#	5
19	10	25	Normal	120	present	8	10	10	25.24	25.27	40.25	120	42.28	30	41.42	130	42.47	40	0	0	30	20	2	20	20	2	4/5	0	#	5
20	20	25	Normal	480	present	15	10	10	18.00	18.09	44.41	10	43.48	100	44.33	166	44.46	70	0	0	43	24	2	23	30	2	4/5	0	#	2
21	20	25	Normal	240	present	16	6	6	26.99	27.03	41.11	94	41.93	4	42.19	52	42.45	142	0	1	24	20	2	14	20	2	4/5	0	#	5
22	20	25	normal	60	present	20	10	10	27.91	22.39	48.01	180	49.85	90	48.42	180	49.56	90	0	1	20	15	2	13	15	2	4/5	0	#	5
23	15	25	normal	480	present	17	10	16	22.64	22.65	44.83	100	46.94	10	44.18	75	47.27	165	0	0	25	25	2	15	25	2	4/5	0	#	3
24	0	5	normal	480	present	7	12	12	16.10	16.00	48.77	10	49.85	100	48.64	166	50.00	76	0	1	25	10	2	18	10	2	4/5	0	#	2
25	25	25	normal	60	present	19	8	8	30.10	29.40	43.77	47	44.64	137	43.86	125	44.56	35	0	1	25	10	2	10	7	2	4/5	0	#	1

S.NO	D LE	TRT	LVA	EXERCISE	FOLLOW UP AFTER SIX MONTHS	DV+PG R	DV+PG L	NV+PG R	NV+PG L	RE SPH	RE CYL	AXIS	LE SPH	LE CYL	AXIS	BCDV R	BCDV L	BCNV R	BCNV L	RS W/M	AGE AP	WS W/M	AGE AP	TRT	LVA
1	5	1				0.7	0.7	0.6	0.6	-10	-3	40	-10	-3	150	0.6	0.6	0.6	0.6	7	2	3	2	1	
2	5	1				0.7	0.7	0.6	0.6	-7	-1.5	180	-7	-1.5	180	0.5	0.5	0.6	0.6	9	2	4	2	1	
3	1	1	6			0.6	0.6	1.2	1.2	-10	0	0	-10	0	0	0.6	0.6	1.2	1.2	50	2	15	2	2	6
4	1	1	5			1	1	4	4	-11.5	0	0	-11.5	0	0	0.9	0.9	4	4						
4	1	1	5			1	1	4	4	-11.5	0	0	-11.5	0	0	0.9	0.9	4	4	9	2	4	2	1	5
5	3	1	6			0.6	0.6	2.5	2.5	0	-2	180	0	-2.5	180	0.6	0.6	2.5	2.5	54	2	30	2	2	6
6	1	1				0.7	0.7	0.8	0.8	-1	0	0	-1	0	0	0.7	0.7	0.8	0.8	25	2	10	2	2	
7	5	#				0.7	0.7	0.8	0.8	-2.5	-3.5	180	-2	-4	180	0.7	0.7	0.8	0.8	10	2	4	2	2	
8	5	1				0.6	0.6	0.6	0.6	-5	-0.5	90	-5	-0.5	90	0.5	0.5	0.6	0.6	10	2	5	2	1	
9	5	1				0.7	0.7	0.8	0.8	-12	-1.5	180	-12	-1.5	180	0.6	0.6	0.8	0.8	10	2	4	2	2	
10	5	1				0.7	0.7	0.6	0.6	-7	-2	30	-7.5	-0.5	180	0.7	0.7	0.6	0.6	20	2	10	2	2	
11	5	1				0.7	0.7	0.6	0.6	-4	-1.5	20	-4	-1.5	180	0.7	0.7	0.6	0.6	7	2	3	2	2	
12	3	1				0.6	0.6	1.2	1.2	0	-4.5	20	0	-4.5	160	0.5	0.5	1.2	1.2	35	2	15	2	1	
13	3	1	7			1	1	2	2	0	-2	70	0	-2	90	0.8	0.8	2	2	12	2	8	2	1	7
14	1	1				0.7	0.8	1.5	1.5	-11	0	0	-11	0	0	0.7	0.7	1.5	1.5	12	2	6	2	1	
15	1	1				0.5	0.5	0.9	0.9	-11	0	0	-11	0	0	0.5	0.5	0.9	0.9	60	2	20	2	2	
16	1	1				0.8	0.7	0.9	0.9	-7.5	0	0	-7.5	0	0	0.7	0.7	0.9	0.9	15	2	7	2	1	
17	5	1				0.5	0.5	0.6	0.6	-4.5	-2.5	180	-5	-2.5	180	0.5	0.5	0.6	0.6	25	2	10	2	2	
18	5	1	8			0.6	0.6	1.3	1.3	-13.5	-1.5	10	-13.5	-1.5	170	0.6	0.6	1.3	1.3	30	2	12	2	2	8
19	5	1		3		0.6	0.6	0.9	0.9	-4.5	-1.5	180	-4.5	-1.5	100	0.6	0.6	0.9	0.9	40	2	22	2	2	
20	2	1	8			0.6	0.6	1	1	12.5	0	0	12.5	0	0	0.6	0.6	1	1	50	2	28	2	2	8
21	5	1				0.7	0.5	2.4	2.4	-8	-1.5	90	-8	-1.5	90	0.5	0.5	2.4	2.4	30	2	15	2	1	
22	5	1				0.9	0.9	1.5	1.5	-21	-2	180	-20	-1.5	150	0.9	0.9	1.5	1.5	25	2	18	2	2	
23	3	1				0.6	0.6	0.8	0.8	0	-3	90	0	-3.5	70	0.6	0.6	0.8	0.8	30	2	18	2	2	
24	2	1	7	3		1.1	1.1	3.7	3.7	15	0	0	15	0	0	1.1	1.1	3.7	3.7	25	2	15	2	2	7
25	1	1	8			0.6	0.6	1.5	1.5	-14	0	0	-13	0	0	0.6	0.6	1.5	1.5	25	2	12	2	2	8

LOW VISION - REVIEW

NO	NAME	AGE	SEX	AS	PS	UCDV RE	UCDV LE	UCNV RE	UCNV LE	RE SPH	RE CYL	RE AXIS	LE SPH	LE CYL	LE AXIS	BCNV LE	C VN RE	DEFECTS	C VN LE	DEFECTS	CS 3M	CS 2M	CS 1M	F
	Pioson	8	1	Normal	Normal	1.2	1.2	3	3	-8.00	0.00	0	-8.00	0.00	0	1	61.9	1	0.3	3	15	25	25	1
2	Anand	11	1	Normal	Normal	1.2	1	1	1	-11.00	-1.00	130	-7.00	-1.00	50	1.4	60.6	2	-42.3	3	15	25	25	1
3	Chinnama	30	2	Normal	Normal	0.6	0.6	0.8	0.8	0.00	-1.50	90	0.00	-1.00	80	0.6	80	1	80	1	0	10	25	1
4	Vijay krishnan	18	1	Normal	Normal	1	1	2	2	-5.50	-1.00	180	-5.50	-1.00	180	1	-49.9	4	-22.7	4	0	5	25	1
5	Sanjay pandi	15	1	Normal	Normal	1	1	4.8	4.8	-20.00	-1.50	50	-22.00	-1.00	90	0.8	-24	2	-6.7	3	0	10	25	1
6	Mubarak	14	1	Normal	Normal	1	1	1	1	-9.50	0.00	0	-8.00	0.00	0	1	61.9	1	61.9	1	5	15	25	1
7	Ajitha	18	2	Normal	Normal	1.1	1.1	0.9	0.9	-5.50	-1.00	180	-5.50	-1.00	180	0.8	-83	3	-11.3	3	5	15	25	1
8	Alagar	12	1	Normal	Normal	1.1	1.1	1.5	1.5	-2.50	-3.50	40	-3.00	-3.50	140	1.2	19.7	2	83	2	0	5	15	1
9	Pradeep	11	1	Normal	Normal	1	1	0.8	0.8	-4.00	0.00	0	-4.00	0.00	0	0.8	67.5	1	-58.1	1	10	25	25	1
10	R.Krishnan	12	1	Normal	Normal	1	1	0.8	0.8	2.50	-5.00	180	2.00	-5.00	180	0.8	60.6	2	-42.3	3	5	15	25	1
11	Mariappan	30	1	Normal	Normal	1.6	1.6	6	6	-22.00	-3.50	30	-18.00	-1.50	20	1.3	76.7	2	81.1	2	0	15	25	2
12	sivanandhan	21	1	Normal	Normal	1.6	1.6	3	3	-16.00	-1.50	20	-16.00	-1.50	160	2	-48.7	3	-5.1	3	0	10	25	2
13	Anjalai	12	2	Normal	Normal	1.6	1.6	3	3	-19.00	-2.00	20	-20.00	-1.00	160	2	73.5	2	79.5	2	10	20	25	2
14	Arulappan	19	1	Normal	Normal	0.5	0.5	0.8	0.8	4.00	1.00	70	4.50	1.00	90	0.8	-83.4	4	-32.7	3	15	25	25	1
15	Sivaguru	8	1	Normal	Normal	0.9	0.9	2.4	2.4	0.00	-2.50	180	0.00	-2.25	180	1.9	63.6	1	69.1	2	5	15	25	1
16	Rathinam	18	1	Normal	Normal	0.1	0.1	0.8	0.8	-1.00	-3.50	20	-1.50	-3.00	160	0.8	-59.8	3	-76.3	4	15	25	25	1
17	Sivasankari	28	2	Normal	normal	1.6	1.6	1.2	1.2	-9.00	-1.50	20	-10.50	-2.00	150	1.2	-85.6	4	-78.4	4	5	20	25	1
18	subramani	17	1	Normal	Normal	0.7	0.7	1.9	1.9	3.00	0.00	0	3.00	0.00	0	1.2	64.7	2	84.1	1	15	25	25	1
19	Alagusree	17	2	normal	normal	0.7	0.7	1	1	0.00	-4.00	30	0.00	-4.00	150	1	45.6	2	57.7	1	15	20	25	1
20	Balasubraman	13	1	normal	normal	0.8	0.8	0.6	0.6	3.50	1.00	90	3.50	1.00	90	0.6	75.7	1	53.6	2	15	25	25	1
21	Raman	7	1	normal	normal	1.3	1.3	1.2	1.2	-9.50	-1.50	180	-10.00	-1.50	180	0.9	-3.6	1	-9.2	2	5	15	25	1
22	Abdul	9	1	normal	normal	0.7	0.7	0.8	0.8	0.00	-4.00	180	0.00	-4.00	180	0.8	61.9	2	80.7	2	5	15	25	1
23	Thabina	6	2	normal	normal	1.3	1.3	6	6	8.00	0.00	0	8.00	0.00	0	2	65.2	1	59.8	1	10	20	25	1
24	Saraswathi	13	2	Normal	Normal	1	1	1.2	1.2	-6.50	-1.00	180	-6.50	-1.00	180	0.9	-37.4	1	-18.3	3	10	20	25	1
25	Hamna	9	2	Normal	Normal	1	1	1	1	-1.25	-3.50	10	-1.50	-3.50	170	1	75.7	1	53.6	1	5	15	25	1

NO	NAME	STEREOP	BSV	FUSION	NPC	NPA	AXL RE	AXL LE	RE K1	Axis	K2	Axis	LE K1	Axis	K2	Axis	MF	MUF	R SpWords/ mi	distance	ap. Age	W Sp words	distance	ap.age	comp	COMMIT	OMISS	D RE	D LE
	Pioson	240	present	15	6	6	27.10	27.40	42.19	177	43.55	87	42.33	16	43.34	106	0	1	26	25	2	11	25	2	4/5	0	2	1	1
2	Anand	60	present	10	8	15	25.50	23.80	46.31	115	47.42	65	47.34	21	48.22	111	0	1	35	20	2	25	23	2	4/5	0	0	5	5
3	Chinnama	240	present	18	16	14	21.20	21.10	47.87	85	48.77	175	48.14	38	48.72	128	0	0	35	25	2	20	25	2	4/5	0	0	3	3
4	Vijay krishnan	60	present	21	12	10	25.50	23.80	46.32	169	47.71	179	47.36	28	47.64	118	0	1	35	25	2	22	25	2	4/5	0	0	5	5
5	Sanjay pandi	120	present	17	10	10	30.90	31.30	42.13	17	44.41	107	42.13	134	43.05	44	0	1	44	25	2	19	20	2	4/5	0	0	5	5
6	Mubarak	120	present	15	12	10	20.50	20.10	42.25	180	43.33	90	42.00	180	43.98	90	0	0	38	18	2	15	10	2	4/5	0	0	5	5
7	Ajitha	0	present	6	10	10	25.30	25.10	42.45	160	43.27	70	42.78	11	43.55	101	0	0	93	25	2	21	15	2	4/5	0	0	5	5
8	Alagar	240	present	16	10	10	22.40	22.20	50.00	28	57.59	128	48.98	129	54.09	39	0	0	58	25	2	14	25	2	4/5	0	0	5	5
9	Pradeep	240	present	17	10	8	24.50	24.40	43.11	14	43.95	104	44.00	174	44.51	84	0	0	38	30	2	14	30	2	4/5	0	0	1	1
10	R.Krishnan	240	present	20	10	10	23.20	23.10	38.75	177	44.51	87	39.00	171	44.23	81	0	0	42	30	2	17	30	2	4/5	0	0	7	7
11	Mariappan	240	present	19	12	10	32.30	30.70	44.06	44	45.42	134	44.27	115	44.87	85	0	1	20	40	2	19	20	2	4/5	0	0	5	5
12	sivanandhan	480	present	15	10	10	27.30	27.50	44.33	7	46.21	97	42.32	172	43.71	82	0	1	53	22	2	20	25	2	4/5	0	0	5	5
13	Anjalai	120	present	12	8	8	28.40	28.30	42.11	10	44.86	90	43.57	165	44.65	90	0	1	26	18	2	12	18	2	4/5	0	0	5	5
14	Arulappan	240	present	20	6	6	19.20	19.00	48.28	173	49.83	83	47.72	20	50.64	120	0	0	47	25	2	25	20	2	4/5	0	0	6	6
15	Sivaguru	240	present	16	8	6	23.10	23.20	42.13	179	44.53	90	42.44	6	44.83	96	0	1	25	20	2	15	20	2	4/5	0	1	3	3
16	Rathinam	480	present	15	12	12	24.40	24.20	44.82	21	53.74	111	45.59	164	51.66	74	0	0	30	25	2	21	25	2	4/5	0	0	5	5
17	Sivasankari	240	present	15	12	8	25.80	24.90	46.68	161	47.87	71	46.04	180	48.55	90	0	0	40	25	2	20	25	2	4/5	0	0	5	5
18	subramani	240	present	15	12	12	20.80	20.35	42.99	180	43.16	90	42.83	180	43.27	90	0	0	28	25	2	22	25	2	4/5	0	0	2	2
19	Alagusree	240	present	15	10	10	23.15	23.06	41.87	28	45.67	118	41.82	161	45.31	71	0	0	98	20	2	37	22	2	4/5	0	0	3	3
20	Balasubraman	120	present	20	10	8	20.03	19.68	46.87	174	48.77	84	47.47	5	48.70	95	0	0	22	30	2	14	30	2	4/5	0	0	5	5
21	Raman	60	present	13	12	15	26.35	26.36	42.99	169	43.89	179	43.44	28	44.29	118	0	1	15	25	2	10	20	2	4/5	0	2	5	5
22	Abdul	120	present	19	8	8	23.34	23.45	42.94	11	46.11	101	42.29	177	45.79	87	0	0	28	25	2	16	25	2	4/5	0	1	3	3
23	Thabina	60	present	11	12	12	19.35	19.38	42.71	90	42.61	180	42.23	90	41.35	180	0	1	2	15	2	5	10	2	4/5	0	2	2	2
24	Saraswathi	120	present	15	12	10	24.17	24.07	46.11	180	47.74	90	46.17	180	47.74	90	0	1	25	20	2	16	20	2	4/5	0	0	5	5
25	Hamna	240	present	17	10	10	24.10	24.33	41.21	7	45.73	97	41.16	172	44.88	82	0	1	22	25	2	13	25	2	4/5	0	0	5	5

NO	NAME	TRT	LVA	EXERCISES	FOLLOW UP AFTER SIX MONTHS	DV+PG R	DV+PG L	NV+PG R	NV+PG L	RE SPH	RE CYL	AXIS	LE SPH	LE CYL	AXIS	BCDV R	BCDV L	BCNV R	BCNV L	RS W/M	AGE AP	WS W/M	AGE AP	TRT	LVA
	Pioson	1				0.5	0.5	1	1	-8	0	0	-8	0	0	0.5	0.5	1	1	30	2	15	2	2	
2	Anand	1		3		0.6	0.6	1.4	1.4	-11	-1	130	-7	-1	50	0.6	0.6	1.4	1.4	40	2	25	2	2	
3	Chinnama	1				0.5	0.5	0.6	0.6	0	-1.5	90	0	-1	80	0.5	0.5	0.6	0.6	40	2	20	2	2	
4	Vijay krishnan	1				0.5	0.5	1	1	-5.5	-1	180	-5.5	-1	180	0.5	0.5	1	1	42	2	25	2	2	
5	Sanjay pandi	1				0.6	0.6	0.8	0.8	-20	-1.5	50	-22	-1	90	0.6	0.6	0.8	0.8	50	2	22	2	2	
6	Mubarak	1				0.5	0.6	1	1	-9.5	0	0	-9	0	0	0.5	0.5	1	1	42	2	20	2	1	
7	Ajitha	1		3		0.5	0.5	0.8	0.8	-5.5	-1	180	-5.5	-1	180	0.5	0.5	0.8	0.8	98	2	27	2	2	
8	Alagar	1				0.5	0.5	1.2	1.2	-2.5	-3.5	40	-3	-3.5	140	0.5	0.5	1.2	1.2	64	2	17	2	2	
9	Pradeep	2				0.5	0.5	0.8	0.8	-4	0	0	-4	0	0	0.5	0.5	0.8	0.8	40	2	15	2	2	
10	R.Krishnan	1				0.5	0.5	0.8	0.8	2.5	-5	180	2	-5	180	0.5	0.5	0.8	0.8	50	2	22	2	2	
11	Mariappan	1				0.6	0.6	1.3	1.3	-22	-3.5	30	-18	-1.5	20	0.6	0.6	1.3	1.3	40	2	20	2	2	
12	sivanandhan	1	4			0.6	0.6	2	2	-16	-1.5	20	-16	-1.5	160	0.6	0.6	2	2	60	2	22	2	2	4
13	Anjalai	1	4	3		0.9	0.9	2	2	-19	-2	20	-20	-1	160	0.9	0.9	2	2	26	2	12	2	2	4
14	Arulappan	1	5			0.5	0.5	0.8	0.8	4	1	70	4.5	1	90	0.5	0.5	2	2	50	2	28	2	2	5
15	Sivaguru	1				0.6	0.7	1.9	1.9	0	-2.5	180	0	-2.5	180	0.6	0.6	1.9	1.9	25	2	15	2	1	
16	Rathinam	1				0.5	0.5	0.8	0.8	-1	-3.5	20	-1.5	-3	160	0.5	0.5	0.8	0.8	35	2	20	2	2	
17	Sivasankari	1				0.7	0.7	1.2	1.2	-9	-1.5	20	-10.5	-2	150	0.7	0.7	1.2	1.2	50	2	24	2	2	
18	subramani	1				0.5	0.5	1.2	1.2	3	0	0	3	0	0	0.5	0.5	1.2	1.2	36	2	24	2	2	
19	Alagusree	1				0.5	0.5	1	1	0	-4	30	0	-4	150	0.5	0.5	1	1	102	2	42	2	2	
20	Balasubraman	1				0.6	0.6	0.6	0.6	3.5	1	90	3.5	1	90	0.6	0.6	0.6	0.6	26	2	15	2	2	
21	Raman	1	6	3		0.6	0.5	0.9	0.9	-10	-1.5	180	-10	-1.5	180	0.5	0.5	0.9	0.9	18	2	10	2	2	6
22	Abdul	1				0.6	0.6	0.8	0.8	0	-4.5	180	0	-4.5	180	0.5	0.5	0.8	0.8	30	2	18	2	2	
23	Thabina	1		3		0.7	0.7	2	2	8	0	0	8	0	0	0.7	0.7	2	2	18	2	12	2	2	
24	Saraswathi	1				0.6	0.6	0.9	0.9	-6.5	-1	180	-6.5	-1	180	0.6	0.6	0.9	0.9	30	2	20	2	2	
25	Hamna	1				0.7	0.6	1	1	-1.5	-3.5	10	-1.5	-3.5	170	0.6	0.6	1	1	25	2	13	2	1	